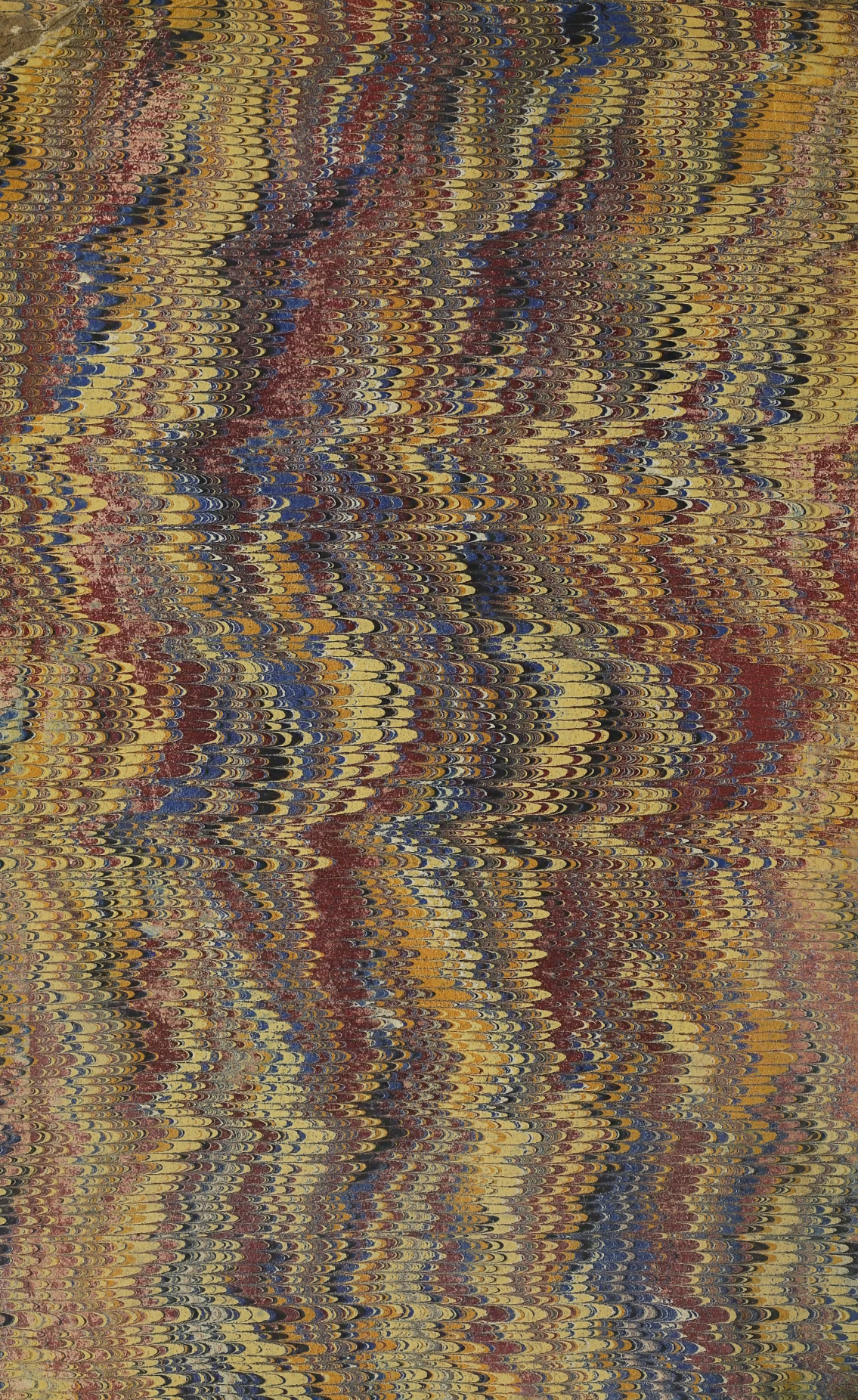

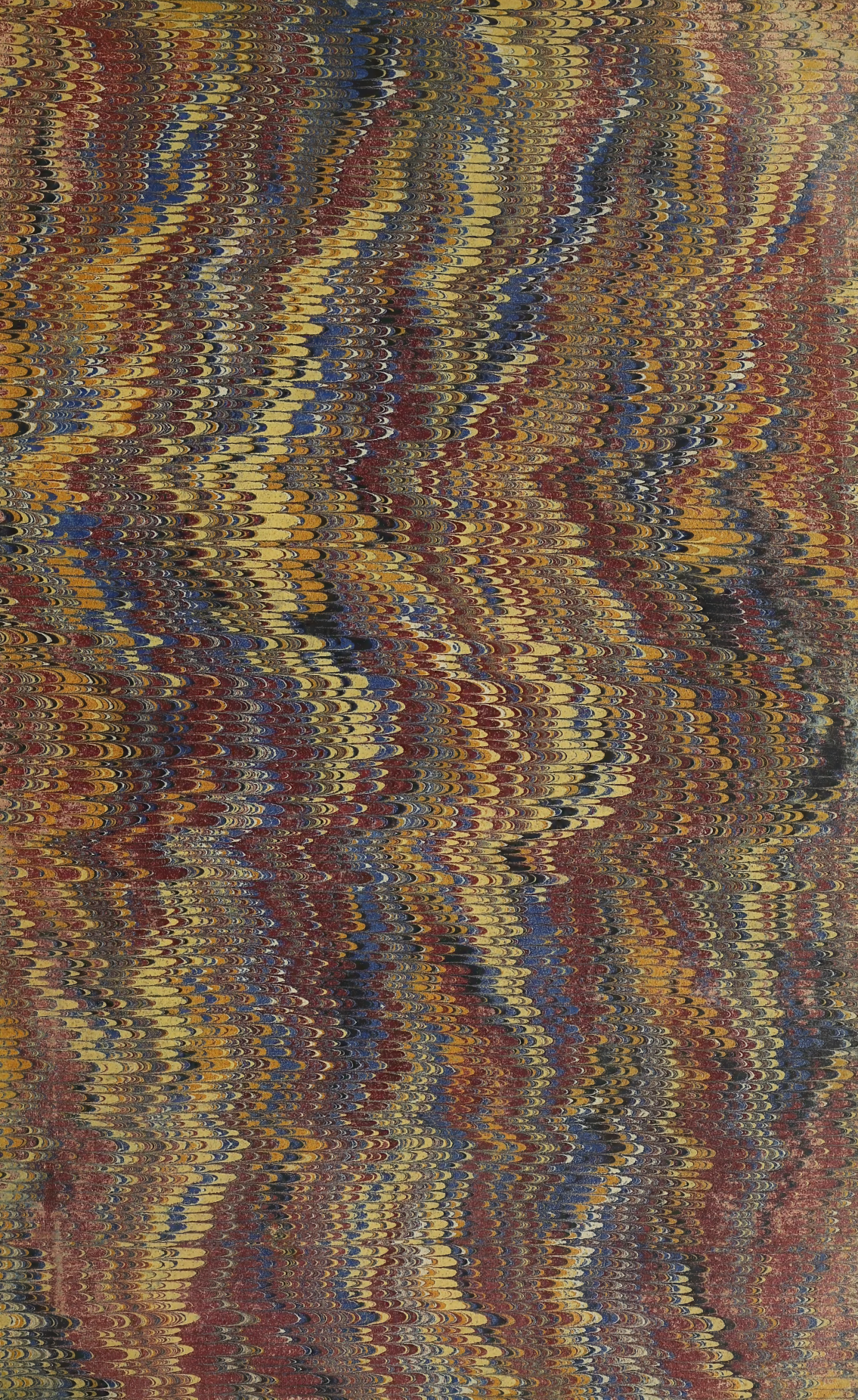

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"Mr. Pond, the author of this work, has certainly directed his attention to a subject which has been almost altogether overlooked in the curriculum of an agricultural education, viz., a system of Farm Book-keeping. Without a farmer has a system of book-keeping, and carefully followed out, there is not much chance of his successfully adapting his knowledge of chemistry to agriculture. We cannot but look upon this work as a means of instructing in accuracy of detail, without which, book-keeping, far less chemistry, will be of little avail.—*North British Railway and Shipping Journal*, 26*th Aug.* 1848.

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THE

RURAL CYCLOPEDIA,

OR A

GENERAL DICTIONARY OF AGRICULTURE,

AND OF THE

ARTS, SCIENCES, INSTRUMENTS, AND PRACTICE,

NECESSARY TO THE

FARMER, STOCKFARMER, GARDENER,

FORESTER, LANDSTEWARD,

FARRIER, &c.

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THE RURAL CYCLOPEDIA.

QUAGGA. See Horse.

QUAGMIRE. See Bog and Morass.

QUAIL,—scientifically *Coturnix*. A genus of gallinaceous birds, of the grouse or partridge family. They are very nearly allied to partridges, but have a smaller body, a slenderer bill, and a shorter tail, and have neither spurs nor red eyebrow. The common quail, called by the old naturalists *Tetrao coturnix*, occurs from Iceland to Southern Africa, and from Britain to China, and is celebrated for its migrations, and is everywhere esteemed as excellent food, and is probably the bird which the patient and all-benign Governor of the Universe gave to the murmuring Israelites as food in the wilderness. It migrates northward in spring and southward in autumn; it alights in clouds on many parts of Continental Europe; it swarms so greatly at the time of migration in Southern Russia and in some countries around the Mediterranean as to be caught by thousands; and though naturally scarce and comparatively poor in Britain, it is imported alive, in great numbers, from France and Germany, to supply the market of London. The male bird is 7½ inches long and 14 broad; his bill is dusky; his head, neck, and back are a mixture of brown ash-coloured and black; the crown of his head and the space above each eye are streaked with a whitish yellow line; his chin, throat, belly, and thighs are dirty yellowish white; his scapular feathers and those of his back are streaked in their middle with light yellow, and on their sides with rusty-brown and black; his wing-coverts are reddish brown, and elegantly barred with black-bounded paler lines; his quills are lightish brown, with small rusty bands on the exterior edges; his breast is of a pale rust colour, spotted with black, and streaked with pale yellow; his tail consists of twelve short feathers, barred with black and very pale brownish red; and his legs are pale brown. The female has less vivid colours than the male, and has no black spots on the breast or side feathers. The nest is a mere hollow on the bare ground, or at best a scooped seat of a few dry leaves or stalks; and it generally occurs among field crops of grass or clover or especially wheat. The eggs vary, in different countries, from 6 to 20; and have a whitish colour, marked with irregular rusty spots. The incubation extends through about three weeks. The young birds, like those of the partridge, run as soon as they leave the shell, and occasionally abandon the mother and begin to be entirely independent of her so early as the eighth day. The quail feeds on seeds, grain, green leaves, and insects; and grows much fatter than the partridge; and is exceedingly indolent; and neither rises soon before the dog nor flies far upon the wing. It is easily inveigled into a net by means of a call in imitation of its natural cry; and it is sought after by the fowler from the period of its arrival in spring till the month of August.

QUAKING BOG. See Bog and Morass.

QUAKING-GRASS. See Briza.

QUAMOCLIT. See Ipomœa.

QUARRYING. Large blocks of stone are only to be procured in rocky places, and the openings or excavations made for obtaining them are called *quarries*. When once a quarry has been opened and is found capable of yielding a large quantity of stone, the qualities of which have been tested by long use and experience, it becomes a very valuable property. From the weight of the material produced, a quarry is unworthy of prosecution unless it has the advantage of water conveyance, and of a railroad for transporting the material to the water's edge; and even with every advantage, it requires considerable forethought and skill to work it with continued advantage. A quarry is seldom a deep excavation like a mine, but consists of working a way into the side of a hill. One of the first things to attend to, therefore, is not to begin the work too low, so as to get the quarry into a hole, from whence it may be very troublesome, dan-

gerous, and expensive to raise large masses of stone, but a road leading into it should be formed and maintained with as gentle a slope as possible, in order that horses may draw the stones up as produced. It is better in the first instance, to so arrange as to deliver the first stones obtained, down hill, instead of having to raise them. But it must be kept in mind, that the elevated stone, and particularly such as outcrops and is visible; and has been exposed to the air, perhaps for centuries, is never so good and sound as that which is hidden or has been protected; and pressure also seems to improve the formation of stone, for that which is deeply situated in the quarry is generally more hard, compact, durable, and better in every respect than that found near the surface, which is tender and friable. On this account it may be necessary to work downwards, but this should be done gradually and with caution.

The first operation should be to remove the incumbent soil (which is called *uncallowing*) to such an extent as will expose the extent of the masses of stone fairly to view. They are called masses, because although the whole rock may seem to be but one mass of stone, yet on closer inspection it will be found, in almost every case, subdivided by natural joints and fissures, too small, perhaps, even for the introduction of a common nail, but in which the stone has little or no natural adhesion; and consequently, at such places one block will readily part from another, without fear of breaking either of them, if the operation is conducted with due skill and care. The horizontal, or nearly horizontal joints or fissures, will be seen without difficulty from the front, and it seldom happens that they are more than from one to four feet asunder, or one below the other. Vertical fissures do not always exist, but if they do, they will be just as obvious as the others. Having found these, the top of the stone must be searched (first moving all that is above it) for the fissure, in a nearly vertical position that corresponds with the front, and should this be found, the entire block of stone that can be obtained in one piece will be seen. The two end blocks that are contiguous to it must now be examined in the same way, in order to determine which of the three blocks shall be sacrificed: for the greatest difficulty is to get out the first block, on account of its being tightly wedged or jammed in by the end ones. One or other must, therefore, be broken, either by a short and heavy miner's pick-axe, or by blasting with gunpowder, or by gads and the hammer; the gad being a thick wedge of hard steel that is held in its proper position, about four or six inches from the fissure, by the two hands of one workman, while it is powerfully struck upon with a sledge-hammer by another, until a sufficient quantity of stone is cut away, to permit the stone that is required to be shifted or moved in a sufficient degree by small wedges driven behind it, under it, and on the undisturbed side of it, to cause it to become detached from its natural bed, when it will be ready for removal: and this, it might be supposed, would be effected by the application of strong iron crowbars or levers to it in the first instance, so as to raise it sufficiently to get hard wooden rollers under it, by which it might be transferred to a platform, inclined plane, or truck, prepared to receive it, and such accordingly is the method adopted for the removal of all large stones that come up with broken or irregular sides and edges, and which will, therefore, require to be *scabbled* or rough dressed by a stonemason, before they can be delivered or used. But, as the value of all large and fine stone is much enhanced by its magnitude, by having no cracks or flaws in it, and by having its faces as flat as possible, and its angles sharp or unbroken, so that the mason in working it need not cut much to waste, the introduction of wedges or levers of sufficient strength to raise its weight, could not fail to destroy its figure by breaking away the edges, and it is, therefore, found more advantageous to lift it from above, than to raise it from below, or at any rate, to have both forces in operation at the same time, so as to cause the lifting action to diminish the weight. This is effected by a very ingenious device well known to every mason under the name of a *Lewis*.

When the natural vertical fissures before spoken of do not occur in blocks of stone, or whenever it may be desirable to raise smaller blocks than they would produce, fissures or cracks must be produced artificially; and this is usually done by drilling a line of holes into the stone at regular short intervals, in the straight lined direction in which the separation is required; a row of conical steel points, rather larger than the holes, are then set one into each hole, and a number of men strike with hammers simultaneously upon them, which, if done equably, never fails to produce a separation of the piece of stone in the direction required. If the stone is found to cleave easily, dry wooden pegs, previously cut larger than the holes, and driven in the same way, will answer the purpose, and is most frequently resorted to for obtaining blocks both of granite and marble in this country. Should the wooden pegs fail, a bank or wall of clay must be built around them capable of holding water, and on filling this, so that the water can sink into the pegs, they will swell with such force as never fails to separate the mass, provided hard and perfectly dry wood has been used.

The drilling of hard stone cannot be effected by ordinary revolving drills. The drill made use of is a steel cold chisel, eighteen inches or two feet long, its breadth being equal to the diameter of the hole to be produced, and its edge being double bevelled and not too acute or sharp. It is held by a workman over the place where the hole is to be made, and struck with a hammer in the other hand, or by a separate man, when the stone is very hard and the hole large. Between each blow of the hammer, the chisel (called a drill) is turned partly round, and is kept revolving or moving backwards and forwards, so that two cuts or blows never come in the same direction, but make a series of indentations like a star, and the powdered stone falling to the bottom, is taken out by a kind of screw-formed spoon, like a screw auger. In this manner holes are made more speedily than might be expected, and they are usually paid for by the inch, according to their size and depth.

The process of blasting rocks by gunpowder requires the same holes to be drilled, but for this purpose they must be deeper and larger than for splitting rocks. From half an inch to three-quarters diameter, and six or eight inches deep will, generally, be sufficient for the splitting holes, while eighteen inches to two feet is a common depth for those used in blasting, and they should not be less than half an inch in diameter. The gunpowder, for convenience of introducing it, is sewed in a linen or flannel bag, or cartridge, having a train that is confined in a straw or small reed; or, if the hole is wet, the cartridge is made of tin, with a fine tin tube to contain the train. Having introduced the powder, dry sand is put upon it, and rammed down, when the remainder of the hole is filled with sand a little moistened. This is called, tamping a hole. Some wild-fire, or powder kneaded with water, or slow match, made of paper, or old linen soaked in saturated solution of nitre, is

made to communicate with the train, and this must be so arranged as to give the person firing it time to retreat before the powder explodes, as fragments of the stone are frequently dispersed with such violence as to be very dangerous. The most hazardous thing in *shooting a hole*, as miners call this operation, is when, by improper fixing of the match, the whole charge explodes the instant the fire touches it, or where it hangs fire, or is so long before it explodes that the workman imagines the match has been extinguished; and, perhaps, goes to inspect it at the very time when it explodes. From both these causes very serious accidents have occurred, and no one ought to approach a hole after the match has been lighted, until such a period has transpired as must render an explosion impossible.

As marble and granite have always to be transported, unless used upon the spot where they are produced, it may be useful to remark, that fourteen cubic feet are considered as equal to a ton weight, on which account a considerable loss frequently accrues to the purchaser; for the cubic quantities are taken by weight, to determine the freight, instead of by measurement; and as the above proportion is not a true one, the cubic feet rarely measure to what is marked upon the stone, or what they are sold for, particularly when it is hard, good, and compact. But lighter and more porous stone will, on the contrary, yield more than fourteen feet to the ton.

QUARTER. The fourth part of any thing; or a division of a carcase comprising one of the limbs; or twenty-eight pounds weight; or a measure of grain equal to eight bushels.

QUARTER-ILL. See Inflammatory Fever.

QUARTZ. A well known mineral species, which surpasses all others in the extent of its distribution. It is also one of the most comprehensive in the varieties it embraces, which are especially numerous as respects colour, lustre, and fracture. Its contents have very improperly been swollen, however, by the introduction of many substances which consist of mixtures of quartz with other species; and the difficulty of forming a correct idea of this group of minerals has been enhanced by their being separated into several species and sub-species, as has been done in certain treatises on mineralogy. We shall endeavour, in the first place, to take a scientific view of quartz; after which we shall point out those varieties which have, from various causes, obtained distinct appellations, together with the mixtures of quartz with other minerals, usually considered as varieties of the species; and, finally, the varieties which are employed in the arts.

The crystals of quartz are, for the most part, regular six-sided prisms, terminated at one or both of their extremities by six-sided pyramids, the faces of which correspond to the sides of the prism, and meet under an angle of 141° 40′. It sometimes happens that the prism intervening between the two pyramids is very short, or even extinct; in which case the form becomes the dodecahedron, with isosceles triangular faces. In the six-sided prism with pyramidal terminations, we often observe the solid angles, situated between the prism and the pyramid, replaced by rhomboidal planes. The alternate faces of the prism are striated horizontally. The primary form is a rhomboid of 94° 15′ and 85° 45′, parallel to whose planes cleavages may be obtained, as also to the planes of the dodecahedron, with isosceles triangular faces, which might also be regarded as the primary form of the species; but the former figure is preferred on account of its simplicity. Lustre vitreous, inclining, in some varieties, to resinous; colour white prevalent; among the brightest colours are violet-blue, rose-red, clove-brown and apple-green. Dark brown and green colours are generally owing to foreign admixtures Streak white; transparent, translucent, frequently opaque, but never, perhaps, unless occasioned by other minerals; hardness between felspar and spinelle; specific gravity 2·69. The crystals often present macles, and sometimes we observe larger crystals, apparently made up of innumerable smaller ones, all of which are so aggregated that their similar faces coincide as respects direction. Implanted globules, reniform and stalactitic shapes, are other modes of occurrence with compound varieties of this species. These have smooth, granulated and drusy surfaces; composition (mechanical) columnar, often impalpable, and frequently a second time composed into granular or curved lamellar masses. The massive varieties present a granular or columnar, and often an impalpable composition, in which case the fracture becomes conchoidal and splintery. Sometimes a second composition produces indistinct granular or thick lamellar masses. Certain very thin columnar compositions, if cut *en cabuchon*, parallel to the fibres, show an opalescent light. We have pseudomorphous crystals, also, of this species, in the shape of cubes, octahedrons, and various other forms, derived from fluor, calcareous spar, gypsum, &c. besides which, quartz occurs in globular and tuberose masses, formed in vesicular cavities, and also in plates and pebbles. The principal varieties of quartz, which are known by distinct names, are the following: 1. *rock crystal;* 2. *smoky quartz;* 3. *yellow quartz;* 4 *amethyst;* 5. *siderite,* or *blue quartz;* 6. *rose quartz;* 7. *milky quartz;* 8. *irised quartz;* 9. *common quartz;* 10. *fat* (*greasy*) *quartz;* 11. *flint;* 12. *hornstone;* 13. *Lydian stone;* 14. *floatstone* (*swimming stone*); 15. *fibrous quartz;* 16. *radiating quartz;* 17. *chalcedony;* 18. *carnelian;* 19. *chrysoprase;* 20. *agate.* Rock crystal is applied to the transparent and colourless crystals, and more particularly to those of a large size. Smoky quartz consists of those crystals and crystalline masses which are translucent and of a brown colour. Yellow quartz, sometimes called, also, *Bohemian* or *Scottish topaz,* is transparent, and of various shades of yellow. Amethyst, also in crystals, and for the most part nearly transparent, is of every shade of violet. Siderite, or blue quartz, is never in regular crystals, but usually compact, and of an azure-blue colour. Rose quartz is confined to translucent massive varieties, of a delicate rose-red colour. Milky quartz is also massive, having an uneven fracture, is translucent, and of a milk-white colour. Irised quartz embraces such crystallized varieties as exhibit in patches, at or beneath the surface, the colours of the rainbow. Common quartz differs from milky quartz simply in being destitute of the milky whiteness of that variety, or in having an inferior degree of whiteness, and more of a vitreous lustre. Fat or greasy quartz differs from common quartz merely in lustre, which, instead of being vitreous, has the appearance of having been immersed in oil. Flint has a more compact texture than common quartz, is dull, only translucent on the edges, of a brownish colour, and breaks with a conchoidal fracture. Hornstone closely resembles flint, from which it can scarcely be distinguished, except in its conchoidal fracture, which is much less distinct. When replacing the fibres of

wood, it is called *woodstone*. Lydian stone, sometimes called *flinty slate*, differs from flint chiefly in having a darker colour, less translucency, and a fracture somewhat slaty; when black, it is often called *bassanite*. Floatstone consists of a delicate tissue of minute crystals, visible only under a powerful magnifier. Owing to the cavities it contains, it sometimes will float on water. Fibrous quartz consists of those varieties which are in distinct, parallel concretions. Radiating quartz is like fibrous quartz, except that the fibres diverge from a common centre, and resemble the radii of a circle, instead of being parallel. Chalcedony includes those varieties of radiating quartz, where the thickness of the individuals becomes so much diminished as to render them nearly or altogether impalpable; its masses generally offer a mammillary or stalactitical surface, and the lustre on freshly-broken surfaces is feeble. Carnelian differs from chalcedony merely in having a blood-red colour. Chrysoprase also resembles chalcedony in composition, excepting that the individuals of which it is made up, appear to be grains instead of fibres; its colour is apple-green, from the oxide of nickel. Agate implies the occurrence of two or more of the above varieties, existing together in intimate union; or it may be applied to a single variety, provided it offers different colours in the same specimens.

Those substances which have formerly been included under quartz, and which are mixtures only of this mineral with other species, are the following: 1. *cat's eye;* 2. *avanturine;* 3. *prase;* 4. *plasma;* 5. *heliotrope;* 6. *iron flint;* 7. *Compostella hyacinth;* 8. *jasper* (*red, brown, striped* and *porcelain*); 9. *jasper-agate;* 10. *Mocha stone;* 11. *Venus-hair agate.* Cat's eye consists of transparent quartz traversed by exceedingly delicate parallel fibres of asbestus; when cut *en cabuchon,* it exhibits, as its position is altered to the eye, a peculiar play of light upon its surface, resembling the changeability of light seen in the eye of a cat. Avanturine is quartz penetrated by small golden-coloured spangles of mica. Prase is quartz penetrated by green fibres of hornblende, which are often so small as to escape detection by the naked eye, and their presence is only discoverable from the green colour they impart. Plasma is a variety of chalcedony, coloured leek-green by some substance not yet examined. Heliotrope is likewise a variety of chalcedony, but coloured by green earth, and occasionally dotted with minute portions of red jasper. Iron flint consists of quartz, intermingled throughout with oxide of iron. The Compostella hyacinth is a red variety of iron flint, in regular six-sided prisms, with pyramidal extremities, which occurs imbedded in gypsum. Jasper differs from the two last varieties in being massive, and in containing variable proportions of clay. Red and brown jasper simply allude to the colour of the compound. Striped jasper appears to contain a larger portion of clay, and is distinguished on account of its striped delineations. Porcelain jasper is regarded as siliceous slate altered by heat, and is found in the vicinity of coal-mines. Those varieties which are found in rounded masses, and which, from the concentric layers of which they consist, appear to have been formed in open spaces, are called *Egyptian jasper*. Jasper agate consists of those varieties of jasper in which several colours are so arranged as to produce an agreeable effect. Mocha stone consists of agate, containing appearances of vegetable filaments, which have been occasioned through the infiltration of iron and manganese through its crevices. Venus-hair agate consists of quartz traversed by delicate hair-shaped crystals of any kind. The most transparent varieties of quartz are pure silex, which, according to Berzelius, contains 49·70 silicon and 50·30 oxygen. Hornstone, flint and chalcedony agree with it in composition. Several varieties contain small quantities of alumine, lime, oxide of iron, &c. Chrysoprase contains 0.01 oxide of nickel.

Quartz is infusible before the blow-pipe, and shows itself to be pure silex. It is dissolved by soda easily, and with effervescence. Two pieces rubbed together emit an empyreumatic odour, and a phosphorescent light. Crystals of quartz may be obtained from a solution of silica in fluoric acid, or in potash diluted with water. The fluid from which crystals of this species are formed, in geodes and other natural cavities of rocks, has been observed to be chiefly water.

With respect to the distribution of quartz, and which we have remarked above to be the most abundant mineral known, it may be said that common quartz enters into the regular mixture of various rocks, of granite, gneiss, mica slate, topaz rock, &c. In others, it occurs in single crystals and in grains, as, for instance, in porphyry, and is frequently met with in the vesicular cavities of amygdaloidal rocks. In these last situations, in particular, are found the finest varieties of chalcedony, carnelian, of jasper and agate. Hornstone forms globules and irregular veins in compact limestone; and flint occurs in a similar manner, but disposed through vast beds of chalk. Quartz, also, occurs in rocks, of which it does not form a regular ingredient; sometimes in masses that are open in their interior, and lined with crystals of enormous size. It also exists in beds by itself, as in quartz-rock, and some varieties of sandstone. Striped jasper and flinty slate form, also, particular beds. The varieties prase and chalcedony, as well as amethyst, are often found in beds of iron ore. River sand, and that of extensive plains, where it is sometimes so fine as to drift before the wind, are formed chiefly of quartz. Common quartz, and several other varieties, are spread all over the earth, but certain varieties are confined to a few localities. The finest and largest rock crystals are found in the Alps of Salzburg, the Tyrol, Switzerland, Dauphiny, Piedmont, and Savoy; also in the isle of Madagascar, Ceylon, and Brazil.

Several varieties of quartz are of important use in the arts and manufactures, and have long been employed for purposes of decoration and utility by mankind. The most important applications of this species to useful purposes, depend upon its being composed of silex. Quartz enters into the composition of glass, both white and coloured. It is added to the mass of porcelain, in the state of an impalpable powder, and forms part of the paste, also, in other kinds of pottery. It is used as a flux in the melting of several kinds of ores, particularly those of copper, and in other metallurgical processes. The use of flint in gun-locks is well known. Lydian stone is employed for trying the composition of mixtures of gold and silver. Sandstone yields various applications for architectural and other purposes, as the construction of melting-furnaces, mill-stones, &c. A variety of sandstone from Villa Rica, in Brazil, which is flexible, deserves to be spoken of in this place. Its flexibility is probably owing to scales of mica disseminated through its mass. Sand, with slaked lime, forms mortar. It is also used, in some countries, for the improvement of roads. See the articles SILICA and SAND.

QUASSIA. A small genus of ligneous, evergreen, tropical plants, of the simaruba order. The bitter species, *Q. amara*, was introduced to Britain from Guiana in the latter part of last

century, but is still rare in collections. It is a very ornamental plant, of naturally about 20 feet in height, and carries red flowers in June and July; and, in common with most or all of the other plants of the simaruba order, it is distinguished for a powerful medicinal bitterness, of great service in dyspepsy, nervous irritability, intermittent fever, dysentery, and kindred diseases. But the two species which furnish the quassia wood and quassia bark of our pharmacopœias, though formerly ranked as true quassias, are assigned by modern botanists to the genus simaruba. See the article SIMARUBA. The peculiar principle of quassia wood, or the dry, brittle, semitransparent, brownish-yellow substance which is left by the evaporation of an alcoholic or watery infusion of it, has been called quassine.

QUEEN-BEE. See BEE.

QUEEN OF THE MEADOW. See MEADOW-SWEET.

QUERCITRON, — botanically *Quercus Tinctoria.* A hardy, deciduous, economical tree, of the oak genus. It is a native of North America, and was introduced to Britain in 1739. It ranks among the red American oaks, and has naturally a height of about 70 feet. Its leaves are sinuate, and have mucronate lobes; and its inflorescence appears in May. Its timber possesses considerable economical value, but is inferior to that of the common oak. Its bark is a well-known and important dye-stuff; and is much employed in dyeing wool, silk, and paper hangings; and is said by Dr. Bancroft, who introduced it to notice, to be equal in power to ten times its weight of woad. With a basis of alumina, a decoction of the bark gives a bright yellow dye; with oxide of tin, it gives a variety of tints, from pale lemon to deep orange; and with oxide of iron, it gives a drab colour. The cellular integument of the bark is what contains the colouring matter.

QUERCUS. See OAK, KERMES OAK, CORK-TREE, ILEX, and QUERCITRON.

QUERN. A hand-mill, comprising two stones, for the grinding of corn in small quantities. It is very ancient, and of very simple structure; yet it is still used in Shetland and some other remote districts of Britain.

QUEY. A young female of the ox species,—intermediate in age between a she-calf and a heifer.

QUICKBEAM. See ASH (MOUNTAIN).

QUICKEN-TREE. See ASH (MOUNTAIN).

QUICK-LIME. See LIME.

QUICKSAND. See FOUNDATIONS.

QUICKS. See AGROSTIS and QUICKSET HEDGE.

QUICKSET HEDGE. A fence of living plants, as distinguished from a dead hedge,—and especially a fence of hawthorn as distinguished from all less resistive fences. The latter also bears the name of quicks. See the articles FENCE, HEDGE, and HAWTHORN.

QUICKSILVER. See MERCURY.

QUIDDING. A temporary cause of unsoundness in a horse,—tending to render him incapable of active work. It consists in the rejection of his hay in a rolled-up form like a quid of tobacco; and arises immediately from inability to masticate the hay, and remotely from a defect in the grinders, or from considerable tenderness of the mouth and pharynx.

QUILLS. The hard and strong feathers of geese, swans, turkeys, crows, ostriches, and some other birds. They are denominated according to their natural numerical order in the wing; and those called seconds and thirds have the largest and roundest barrels, and are the best for writing. Prepared or clarified quills are comparatively good or bad according to the size and solidity of their barrels, according to their weight, and according to their relative degrees or mutual combination of hardness and elasticity. Large quantities are annually imported into Britain from Holland, Germany, and Russia. Their barrel consists of coagulated albumen. See the article FEATHERS. The quills of crows are used principally for drawing.

QUILLWORT,—botanically *Isoetes.* A small genus of curious aquatic plants, of the marsileaceous division of cryptogams. The marsh species, or European quillwort, or Merlin's grass, *Isoetes palustris,* inhabits the shallow parts of limpid upland lakes in the mountainous districts of Britain. It has a perennial tuberous root, and sends down from it long, simple, and somewhat hairy fibres perpendicularly into the ground, and has no stem, and comprises a tuft of many quadrangular awl-shaped fronds of from 3 to 9 inches in height, and carries a brown inflorescence from May till October. Fishes are said to feed and fatten on it.

QUINA. See PERUVIAN BARK.

QUINCE,—*Cydonia.* A small genus of hardy, deciduous, fruit-shrubs and fruit-trees, of the rose-tree order. Three species are in cultivation; but the common one of these, *Cydonia vulgaris,* is by far the most interesting. It has crooked branches, and a spreading, bushy head. It is indigenous to Germany and the south of Europe; and it appears first to have attracted notice in the city of Cydon, in Crete or Candia—whence its botanical name, *Cydonia.* The fruit is of a fine golden yellow, and more nearly resembles that of the orange than any other. It was even more highly esteemed by the Greeks and Romans, for preserving, than by us. "Quinces," says Columella, "not only yield pleasure, but health." The quince seldom grows higher than fifteen feet, and is usually rather a shrub than a tree. Its large white and pale pink blossoms, which appear rather later than those of other fruit trees, are quite ornamental; and the tree, properly grown, is very ornamental when laden in October and November with its ripe golden fruit. Three chief varieties of it occur in gardens,—the apple-shaped, the pear-shaped, and the Portugal; but only the last of these is well worthy of cultivation.

The quince is, in all its varieties, unfit for eating raw. It is, however, much esteemed when cooked. For preserving, it is everywhere valued, and an excellent marmalade is also made from it. Stewed, it is very frequently used, to communicate additional flavour and piquancy to apple-tarts, pies, or other pastry. In England, wine is frequently made from the fruit, by adding sugar and water, as in other fruit wines; and it is a popular notion there, that it has a most beneficial effect upon asthmatic patients. Dried quinces are excellent.

The quince is easily propagated from seed, layers, or cuttings. From seeds the quince is somewhat liable to vary in its seedlings, sometimes proving the apple-shaped and sometimes the pear-shaped variety. Cuttings, planted in a shaded situation, early in the spring, root very easily, and this is perhaps the simplest and best way of continuing a good variety. The better sorts are also frequently budded on common seedling quince stocks, or on the common thorn. Quince stocks are extensively used in engrafting or budding the pear, when it is wished to render that tree dwarf in its habit.

The quince grows naturally in rather moist soil, by the side of rivulets and streams of water. Hence it is a common idea that it should always be planted in some damp neglected part of the garden, where it usually receives little care, and the fruit is often knotty and inferior. This practice is a very erroneous one. No tree is more benefited by manuring than the quince. In a rich, mellow, deep soil, even if quite dry, it grows with thrice its usual vigour, and bears abundant crops of large and fair fruit. It should, therefore, be planted in deep and good soil, kept in constant cultivation, and it should have a top-dressing of manure, every season, when fair and abundant crops are desired. As to pruning, or other care, it requires very little indeed — an occasional thinning out of crowding or decayed branches, being quite sufficient. Thinning the fruit, when there is an over-crop, improves the size of the remainder. Ten feet apart is a suitable distance at which to plant this tree.

QUINCUNX. A disposition of four trees at the corners of a square, and one in the middle of it. This disposition, often repeated, forms a regular grove, which, when viewed from any angle of the aggregate square or parallelogram, is seen to have equal parallel alleys. See the articles Orchard and Plantation.

QUININE. See Peruvian Bark.

QUINOA. See Goosefoot.

QUINSY. A disease in hogs similar to strangles in horses. It comprises sore throat, enlargement of the glands of the throat, and inflammation of the cellular substance between the skin and muscles beneath the lower jaw. It progresses rapidly, and causes so great a swelling as to impede breathing and threaten suffocation; yet when timeously and promptly treated, it is seldom dangerous. The proper remedies are bleeding and a good dose of Epsom salt, followed by a small dose every six hours, and the occasional offer of some weak warm washy food, till the bowels become freely opened.

QUISQUALIS. A genus of ornamental, tropical, climbing plants, of the combretum family. The Indian species, *Q. indica*, was introduced to the stoves of Britain in 1815; and is eminently beautiful. It attains a height of about 20 feet, and blooms in constant beauty and profusion from the beginning of April till the middle of October, and enlivens the whole stove with the delicious fragrance and the varying hues of its bunches of changeable orange and ruby-coloured flowers. It is easily propagated and cultivated. Two other species, the smooth and the pubescent, were introduced in the same year, and attain the same height; and all the three love a soil of loamy peat, and are propagated from cuttings.

QUITCH. See Agrostis.

QUIT-RENT, in law. A small rent that is payable by the tenants of most manors, whereby the tenant goes quit and free from all other services. Anciently this payment was called white-rent, because it was paid in silver coin, and to distinguish it from rent-corn.

QUITTOR. A fistulous sore in the coronet of the horse's foot, generally on the inside, or appearing from within at or near the junction of the skin and hoof. It is caused sometimes by direct injuries to the coronet, as by treads, abrasions, and over-reaches, — but more commonly by punctures, bruises, lacerations, pricks in shoeing, or neglected corns in the lower part of the foot,—giving rise to suppurative inflammation. The pus, finding no outlet through the insensible and unabsorbable horn, works its way upward, and discharges itself at the coronet. The ulceration has only a small opening; but, except in slight cases, it may be ascertained by the probe to extend and ramify through a considerable amount of sinuses; and if allowed to proceed without proper treatment, it effects an extensive separation of the wall of the foot from the sensible parts, and sets up inflammation in the side cartilages, and even communicates disease to the bones. In all bad cases, the services of an experienced and scientific practitioner are indispensable; and, in any cases, however slight, the blind and butcherly behaviour of those pretenders who wantonly wield the knife or the red-hot iron against masses of healthy parts as well as of destroyed ones, ought to be avoided and abhorred. "The ordinary mode of cure," says Mr. Percivall, "consists in the introduction of caustic into the sinus; and so long as the cartilage preserves its integrity, or is free from caries, this is perhaps the most prompt and effectual mode of proceeding. The farrier's practice is to mix about half a drachm of corrosive sublimate in powder with twice or thrice the quantity of flour, and make them into a paste with water

This he takes up by little at a time with the point of his probe, and works it about in the sinus until the paste appears rising in the orifice above. After this is done, he commonly has the horse walked about for an hour or two, or even sent to slow work again, which produces a still more effectual solution of the caustic, at the same time that it tends greatly to its uniform and thorough diffusion into every recess and winding of the sinus. The consequence of this sharp caustic dressing is a general slough from the sinus. Every part of its interior surface is destroyed, and the dead particles become agglutinated, and cast off along with the discharges in the form of a dark firm curdled mass, which the farrier calls the core; and so it commonly proves, for granulations follow close behind it, and fill up the sinus." But in the majority of cases which are referred to the experienced surgeon, and certainly in all bad ones, more complex treatment is requisite, and the removal of much of the sole and wall is indispensable; and in all such cases, the following practice of Mr. Newport may be followed:—"After the shoe has been removed, thin the sole until it yield to the pressure of the thumb; then cut the under parts of the wall in an oblique direction from the heel to the anterior part, immediately under the seat of complaint, and only as far as it extends; and rasp the side of the wall thin enough to give way to the pressure of the over-distended parts; and put on a bar shoe rather elevated from the frog. Ascertain with a probe the direction of the sinuses, and introduce into them a saturated solution of sulphate of zinc, by means of a small syringe. Place over this dressing the common cataplasm or turpentine ointment; and renew the application every 24 hours. I should recommend that, when the probe is introduced, in order to ascertain the progress of the cure, it be gently and carefully used, otherwise it may break down the new formed lymph." See the article FISTULA.

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RABBIT. Several species of gnawing quadrupeds of the same genus as the hare,—or of the genus Lepus, and order Rodentia. See the article HARE.

The American rabbit, *Lepus Americanus*, *L. Brasiliensis*, or *L. nanus*, is similar in size and colour to the common or European rabbit. It has reddish feet, and has no black on either ears or tail. It nestles in the trunks of trees, and often ascends their hollows as far as to their branches. Its flesh is insipid and soft.—The Siberian rabbit, *Lepus tolai*, is intermediate in character between the common rabbit and the common hare, and occasionally exceeds the latter in size. It makes no burrows, but seeks shelter in the clefts of rocks or other cavities.—Some other species or permanent varieties, occur in other distant countries; but, like the first of the two we have noticed, and like the black-necked rabbit of India, they can be distinguished from the common rabbit, only by minute or very unimportant characters.

The common rabbit, or European rabbit, *Lepus cuniculus*, comprises almost all the varieties, both wild and tame, which occur in Europe. It is smaller than the hare, and has shorter hind legs and more thinly covered ears. Its ears also are somewhat shorter than its own head; its tail is shorter than its thigh; and its fur has predominantly a yellowish grey colour, with some red on the neck and some brown on the tail, but is whitish on the throat and belly, and grey without any black on the ears. But it varies somewhat in size, considerably in the qualities of its flesh, and very greatly in the colours of its fur, according to differences of breed and diversities in the mode of living. The wild rabbit is smaller than the tame, and is less white and less delicate in flesh, but has more of the game flavour, and brings a higher price in the market. The tame rabbit is widely diversified in both size and colour. The largest kinds are generally the best for breeding; the broad-chested and short-legged kinds are the hardiest and the most rapid fatteners; a large variety of the hare colour has more highly coloured and more highly flavoured flesh than any of the other tame kinds; large varieties of white or of white and yellow colours have comparatively very white and delicate flesh, and may be so cooked as to rival the turkey; and the varieties called French and Turkish rabbits differ little from the common kinds, yet are much esteemed.

The common rabbit, though now dispersed through most of Europe, seems to have been a native of Spain, and loves a temperate or even warm climate, and cannot without difficulty endure great cold. It abounds in many districts of Britain; and is specially plentiful in the sandy tracts of Norfolk, Suffolk, Cambridgeshire, and Lincolnshire. It is amazingly prolific, and but for being kept down by hawks, foxes, polecats, weasels, and men, it would soon

overspread entire districts and become a terribly devastating nuisance. In the time of the ancient Romans, it so swarmed in all the Balearic Islands that the inhabitants were obliged to implore a military force from the Emperor Augustus to exterminate it; and in quite recent times, it so greatly oppressed the Island of Minorca that the population had to be called out by the Governor during two days in every year to destroy it. It becomes capable of breeding at six months old, and can breed seven times in the year, and produces from 5 to 10 young ones in each brood, and lives to the age of 8 or 9 years. One calculation supposes that, in four years, a pair may multiply to the number of 478,062; and another that they may multiply even to 1,274,840. But though the latter calculation seems quite within the limits of possibility, even the former is probably never, or at least scarcely ever, within the limits of fact. A curious circumstance is, that, from the moment of birth till they reach the age of six weeks, the young are liable to be destroyed by the male; and this circumstance concurs with the predations of many keen and vigilant enemies to keep down the numbers. The female goes with young 30 or 31 days; she scratches out a burrow about two feet deep, and makes a bed of down from her own fur, in preparation for her accouchement; and she tends and suckles her young with wonderful solicitude, and never leaves them except to get supplies of food, and does her best to conceal them from the killing knowledge of the male, and leads them to the warren at the end of six weeks when they cease to be objects of his dislike.

The wild rabbit is reared in warrens, in a state of comparative liberty. It is valued partly for its fur, which is used chiefly in the manufacture of hats,—and partly for its flesh, which, though not much esteemed in Britain, is yet consumed to a considerable extent in our large towns. Warrens are exceedingly varied in both character and extent. They are most economical in sandy downs, which possess little adaptation to any other purpose; they should be enclosed by a wall, both to keep out depredators, and to prevent the rabbits from making havoc on the neighbouring fields; and, if not naturally stocked, they may be furnished at the rate of three couples to the acre, and in the proportion of one male to every 7 or 8 or 10 females. Mice, rats, and other vermin which may threaten to infest them must be destroyed. Any rich soil, besides being too costly, is unsuitable on account of the tendency of a flush of grass to produce a general and destructive dysentery. Many ordinary sheep-walks would do well for warrens, but are more profitable for sheep-feeding; and almost all sandy or other loose-soiled hills were formerly thought to be peculiarly suitable for them, but even these are now found, in most instances, to pay better when used in some other way. Rabbits in warrens are caught either with fold nets, or with spring nets, or with a peculiar kind of trap, or with the aid of the ferret; and rabbits in covers or hedge-rows, started and hunted out by dogs, are shot in the way of sport. The best time for bringing their fur to the market is from October till January; and the best time for shooting them is when snow lies on the ground.

Rabbits in natural burrows or in ill-enclosed warrens sometimes prove a great nuisance to farmers. "A correspondent in your paper," says a writer in the Irish Farmer's Journal, "enquires how he may prevent the rabbits from frequenting his land, or how he may stop them from burrowing, &c. Last autumn, I planted, that is dibbled, a field of wheat; and after it came up, I found the rabbits had eaten off the greater part of the outside of the land. Wishing to stop them, I bought some soot, and had it thinly strewed over those outsides where the rabbits came, and some refuse lime from the gas-works over some of the adjoining lands; and I do not think the rabbits have ever touched it since. Some gas tar poured into their holes, I have no doubt, would compel them to forsake the same."

The tame rabbit can be reared with little trouble and at very small expense. It will, of course, be kept only in situations where a proper market exists for it, or by families who wish it for their own use; but were it duly appreciated, and properly understood, it might, in many a place where it is at present unthought of, and by many a family of limited means, be made to furnish, readily and economically, a grateful change of nourishing and wholesome food. It is extremely delicate when used immediately after it has been suckled; and it becomes very agreeable when properly fed with hay, green plants, roots, farinaceous substances, and steamed potatoes through a period of about three months. But thorough attention must be given to proper feeding, to dryness, to cleanliness, and to ventilation. The boxes or compartments used for rabbits, and popularly termed hutches, should be placed on the top of one another round the sides of an airy room, or sufficiently sheltered division of an outhouse. Single hutches are suitable enough for males or for weaned young ones; but double hutches, or hutches with two divisions, the one for sleeping in and the other for feeding in, are requisite for the breeding females; and all the single hutches and feeding divisions of the double ones, should be furnished with troughs for containing the food. The female, except at a brief period six or eight weeks after she has brought forth, ought always to be kept completely inaccessible to the male; and whenever her time of accouchement approaches, she must be furnished with a little hay.

A method of keeping tame rabbits in a manner approaching the liberty and wildness of the warren, has been recommended as follows:—"In any part of the premises that may be considered

eligible, a stable yard for instance, let the earth be removed, 6 feet deep and 3 wide. A foot from this square hole, let another be dug of the same depth, and 4 feet wide,—the latter to be bricked all round, and divided from the smaller space by a brick partition, open at the bottom large enough to admit a full grown rabbit. Down this party wall an iron plate is to be slided at pleasure, by a rope from above. This forms the communication between the two apartments, the former of which, the smaller, we will call the warren, the latter, the trap. Light covers of wood, or even of tarred sailcloth, stretched and nailed on a frame of wood, are to be adapted to each space, either with hinges, fastened to a lower frame, or entirely moveable. The trap, or larger bricked compartment, is also the feeding place, into which not only garden vegetables may be thrown, but troughs containing bran and oats are to be let down, fastened to the ends of sticks of a convenient length, perhaps 4 feet. As soon as the stock of rabbits is placed in their future home, the animals will begin to burrow in the warren (the brick-work will prevent them from doing this in the other space); and when they are hungry, they will naturally pass through their door to obtain the food which will await them in the trap. The iron sliding door of communication will of course never be let down but for an express purpose,—the chief obviously being to catch and select them while they are assembled at their meal."

RABIES. See Hydrophobia.

RACE. A variety or breed of horses or cattle or other domesticated animals; also, a trial of speed between two or more animals, particularly between two or more horses. See the articles Racing and Horse.

RACEME. See Inflorescence.

RACEMIC ACID. A vegetable acid found readily in the grapes of certain districts, and probably occurring more or less in all grapes. It is nearly akin to tartaric acid, not only in being naturally associated with it, but in having a similar and even isomeric constitution.

RACHIS. The flexuous axis of the inflorescence of the grasses; also the petiole and midrib of the frond of ferns.

RACING. A trial of speed, under stringent conditions, and in the way of public gaming and amusement, between two or more trained racehorses. We have said enough respecting racehorses in the article Horse; we have not a word to say respecting the gaming and the general spirit of the English race-course except to denounce them as immoral; and we need not usurp the functions of the Racing Calendar in detailing the rules and practices of the turf, as nobody is likely to consult us for such information. We shall merely say that, if ever racing can be made to comport in any tolerable degree with right feeling or common sense, it must both renounce gaming and cruelty, and directly address itself to some useful purpose. "It must be obvious," says an able writer, who is very far from according with us in dislike to the thing itself, "that the practice of racing should be such as to encourage and promote the qualities desired to be perpetuated, and such as are of the greatest public value. Thus in Persia, continued speed being the object required, the race is protracted for several days, so as to be a severe test of endurance,—a quality of considerable importance in travelling from one part of the country to the other, and in transmitting expresses. On the contrary, in South America, where sudden speed is useful, and commonly called for in taking wild cattle, the race is exceedingly short. In these instances, the qualities sought to be encouraged are those of the greatest and most common use. So in England something besides speed being requisite, it should be the study of those possessing influence in these matters, to direct the public taste to the encouragement of qualities of national importance. Marshal Marmont judiciously observes on this topic, that 'Les encouragemens, les prix, les primes, devraient être calculés sur des épreuves applicables aux besoins des divers usages publics et domestiques et non pas être la recompense d'un mérite idéal.'" [Winter's Horse in Health and Disease.]

RACK. See Hay-Rack.

RADIATED FLOWERS. Composite flowers which have their outer florets in a radiated or stellate arrangement. They are distinguished by their form from discous flowers.

RADICLE. The part of the embryo of a plant which, in germination, descends through the soil and becomes the root. The name radicles is also given to the rootlets or radical fibres of a plant, to distinguish them from the main body of the root.

RADIOLA. A curious, little, annual, British plant, of the carnation order. It grows in sandy situations, and has a height of only one or two inches, and carries white flowers in July and August. It constitutes a genus of itself, and is called specifically *millegrana*, and popularly all-seed. Its generic name radiola signifies 'a little ray,' and alludes to the radiated form of its capsule.

RADISH,—botanically *Raphanus*. A genus of herbaceous plants, of the cruciferous order. It is nearly allied to the mustard genus, but may readily be distinguished from it by the form of its pods, which are many-celled or divided into several joints. Two species grow wild in Britain; two have been introduced from other countries; and several more are known. One of the indigenous species is noticed in the article Charlock; and one of the introduced species, in the article Landra. The other indigenous species, *Raphanus maritimus*, is a tap-rooted weed of the sea-coasts of Britain, commonly about 3 feet in height, and carrying yellow flowers from May till July.

The cultivated radish, *Raphanus sativus*, concentrates in itself the main interest of the genus. It is a native of China, and was introduced to Britain about the middle of the 16th century. Its root is annual and fusiform; its stem is about 3 feet high; its leaves are lyrate or sublyrate and rough; its flowers are whitish or tinged with purple, and naturally bloom from May till June; and its pods are uneven, tapering to a point, generally two-celled, and about as long as their stalks. It comprises many varieties, and is used for several purposes. The roots of most of the varieties are eaten raw, and highly relished, by all classes of the community, and serve the double purpose of gratifying the palate and acting as an antiscorbutic; the unripe seed-pods are used in pickles; the young green tops are used as small salading; and the seeds of several varieties, particularly those of *R. s. olifer*, are somewhat valuable for their oil. One classification of the varieties groups them into the small-rooted and the Spanish,—and distributes the former group into the round-rooted, the oblong turnip-rooted, and the oil-bearing,—and the latter group into the common, the black, the round, the grey, and the white; another groups them into the Spanish, the oblong, the turnip-rooted, and the long crooked,—and distributes the first of these groups into the black and the white,—the second into the red and the rose,—the third into the crimson, the early rose, the white, and the yellow,—and the fourth into the purple, the early scarlet frame, the purple-top white, the salmon-coloured, the scarlet short top, the white Italian, and Wood's early dwarf frame; another groups them into the fusiform-rooted spring varieties, the turnip-rooted spring varieties, and the autumn and winter varieties,—and distributes the first of these groups into the long white or white Italian, the white Russian, the twisted, the purple or short-topped, and the red-necked white,—the second into the white, the early white, the pink or crimson, the purple, and the yellow,—and the third into the late yellow, the round brown, the oblong brown, the white Spanish, the black Spanish, and the purple Spanish or large purple winter; and some other classifications, not only make different groupings from these, but include some other varieties or subvarieties, and give some of the same varieties other names. In a general view, the fusiform-rooted kinds are the best for main and early crops, the turnip-rooted kinds for secondary crops and change, and the Spanish kinds, and a new sort called the Breadalbane, for autumn and winter use.

The soil most suitable for the radish is a friable or porous and moderately fertile loam; and it should be dug to a good depth, and very finely pulverized. The situation, for early crops, must be warm and sheltered, yet, for both early and late ones, should be fully open to air and sunshine. Manure ought not to be applied in immediate preparation for the crop; or, if indispensable, must be in a finely divided state, and thoroughly intermixed with the soil. The seed may be sown in hotbeds for use in December, January, and February, and in the open ground for use at other seasons; and it may be sown monthly in winter, and fortnightly throughout spring and summer, and that of the Spanish kinds in July and August. The sowings in the open ground may be either broadcast on beds of 4 or 5 feet wide, or in drills of 3 inches asunder for the fusiform-rooted kinds, of 4 or 5 inches asunder for the turnip-rooted kinds, and of 6 or 8 inches asunder for the Spanish kinds; and they must, in every case, be thin and to the depth of about half an inch. The seedlings when so far up as to have each 5 or 6 leaves must be thinned,—the fusiform-rooted to distances of 3 inches, the turnip-rooted to 4, and the Spanish to 6. In moist hot weather, the spaces must be greater than these; and in dry weather, a watering ought to be given every night. Sowings and germinating crops which have to contend with frost, whether in the latter part of the year or in the early part, must be constantly protected by some sufficient covering; and rising crops, in the same predicament, must be similarly protected throughout the night and during every severe day, but fully exposed in mild or open weather. When roots come to be ready for use, the bed should be copiously watered 24 hours or so before they are drawn, and not watered again till after they are drawn; and they should be drawn early in the morning, and laid in a cool damp place till the hour when they are wanted for use. In November, the kinds which have been grown for winter use must be taken up during dry weather, and stored among sand for preservation; and the best of these kinds, if grown at sufficient widths, and if taken up and stored in this way, will retain their good quality till spring.

The seed of the hotbed crops must be sown on a layer of mould about 8 inches deep, and covered to the depth of half an inch with a sifting of mould. The proper time of sowing is the juncture immediately after the abatement of the violent heat of the hotbed. The plants will appear above the surface in less than eight days, and will be ready for use in the course of six weeks. Air must be given as long and freely as possible; but the glasses must always be closed toward evening, and a covering of mats or some other substance must, at all needful times, be given proportionately to the severity of the weather. The requisite temperature is from 50° to 70°; the distances of the plants from one another must not be less than two inches; and, at any time when the mould appears dry, a light watering must be given about noon. Crops raised in spring in a cold frame, with due protection, are two or three weeks earlier than contemporaneous and duly protected crops in the open ground.

Sowings for furnishing young green tops as small salads, should be made once a-week. Plants of any of the early or summer varieties intended to yield seed, should be selected from a main crop at the time of its greatest vigour, and taken up with the least possible injury to the roots, and dibbled in, quite down to the leaves, in rows at distances in every way of about 3 feet, and watered freely till they become established, and afterwards watered occasionally as the needs of their growth and the state of the weather may require. Plants of the Spanish or other late kinds intended to yield seed should either be raised from a special sowing in March, or transplanted in that month from a crop which has stood over the winter. Pods for pickling must be gathered while young and tender; and pods for seed, when they acquire a brown hue. Two varieties must not be raised for seed in the vicinity of each other; but every variety must be brought to seed with the same precautions against natural hybridizing which are necessary in the case of cabbages and borecoles. See the article Brassica.

Field crops of radishes are raised on the rich loamy soils of the Isle of Thanet and East Kent, for the supply of the seeds to the London market. "The radish seed is sown in furrows, about 10 inches apart, in a dry time of the month of March, at the rate of about 2 or 3 gallons per acre. As soon as the plants appear, every other row is cut up with a horse-hoe, leaving the rows 20 inches apart. When the plants get 2 or 3 rough leaves, they are hoed out in rows, and are then kept clean by repeated horse and hand hoeing, when necessary; leaving the plants at about 18 inches distance. The crop is seldom fit to reap till October, and is sometimes out in the fields until Christmas, without receiving injury from the wet weather, it being requisite to allow it much rain, in order to rot the pods and facilitate its thrashing. The produce is from 8 to 24 bushels per acre."

The oil radish, *R. s. olifer*, has a height of only from 6 to 24 inches, and is very much branched and spreading, and produces more seed pods than any of the common varieties. It is somewhat extensively grown in China for its oil; and has, for some time past, been cultivated in several parts of Continental Europe; and has been a good deal recommended as a general substitute for rape. But it does not seem to have been anywhere very successful in Europe; and it does best in countries, such as those upon the seaboard of the Mediterranean, where it can be sown in autumn and reaped in the end of spring or beginning of summer; and it is too tender to bear sowing in the fields of any part of Britain till after the disappearance of the frosts of spring. Its oil, too, though somewhat superior to that of rape, is more difficult of expression.

RADISH (Horse). See Horse Radish.

RAFFLESIA. A genus of wonderful, ornamental, tropical plants; nearly allied to the passion-flower and the pitcher-plants, but properly constituting an order of its own. Arnold's species, *R. Arnoldii*, is the most gigantic known flower in the world, and is all flower together, and yet is merely a parasite, growing on some crack of the root or stem of a vine or of some other vast climber, which are attached like cables to the largest trees of the tropical forests. It was discovered in 1818, in the Island of Sumatra, growing close to the ground under bushes, with a swarm of flies hovering over its nectary, and apparently laying their eggs in its substance. It is called by the natives krubut or the great flower, or ambum-ambum, wonder-wonder, or the flower of flowers. It has neither root, stem, nor leaves; yet, when full grown, it weighs of itself about 15 lbs., and has a breadth of upwards of 3 feet. It is dicœcious; and the male of it was brought to Britain soon after its discovery. Its first appearance is that of a round knob; and this, when cut through, exhibits the infant flower enveloped in numerous bracteal sheaths, which successively open and wither away as the flower enlarges until at the time of full expansion, very few remain, and have somewhat the appearance of a broken calyx. Three months elapse from the first appearance of the bud to the full expansion of the flower. The segments of the perianth are 5 in number, roundish, of a brick red colour, covered with protuberances of a yellowish white, and measure 12 inches from the base to the apex. About a foot intervenes from the insertion of one petal to that of the opposite. The nectary would hold 12 pints. The pistils are nearly as large as cow's horns. The female flower differs little in appearance from the male, except in wanting anthers; and, in its decay, it extricates seeds or spores, which are dispersed throughout its pulpy mass.—The Patma species, *R. Patma*, occurs in the south of Java, and varies in the diameter of its full-sized expansion from about 11 to about 25 inches, and is not dicœcious.

RAFNIA. A genus of ornamental, evergreen, yellow-flowered, Cape-of-Good-Hope plants, of the genista division of the leguminous order. Five or six species, chiefly shrubby and about 2 or 3 feet high, have been introduced to the greenhouses of Britain; and a number more are known. The best soil for the introduced ones is a sandy loam.

RAFT. A quantity of timber linked close together in such a manner as to be conveniently floated along a river or canal or lake.

RAFTER. A four-sided piece of timber used in roofing houses.

RAFTERING. Sawing logs of wood or planks of trees into rafters; also, the ploughing of one half of a grass field in such a way as to turn the grass side of each ploughed furrow on the land which is left unploughed. The raftering of land is practised chiefly in Wiltshire, and is a cheap and slovenly way of rendering loose land firm for

sowing, or of imitating the mechanical effects of sheep-folding. The operation is performed as early in autumn as the land can be wanted from pasturing; and the land, after undergoing it, lies untouched till near seed-time, and is then harrowed down and ploughed preparatorily to sowing.

RAG. See Rags.

RAGGED ROBBIN. The cuckoo-flower or *Lychnis flos-cuculi*. See Cuckoo-Flower.

RAG FALLOW. See Fallow.

RAGS. Torn and worn pieces of any kind of cloth. Linen rags, by means of the simple agency of sulphuric acid, yield more than half their weight of sugar; and both they and cotton rags form a very important commodity throughout Europe for the manufacture of paper.

Woollen rags are a valuable manure, particularly for hops, fruit-trees, and vines. They contain a very large proportion of albuminous matter, and minute portions of lime and silica, and traces of various salts. Wool, according to analysis by Scherer, comprises 50·653 per cent. of carbon, 7·029 of hydrogen, 17·71 of nitrogen, and 24·608 of oxygen and sulphur. Both woollen rags and the waste clippings of fleeces, therefore, are powerfully nutrimental to crops; and they decompose slowly in the soil, and attract and retain moisture, and generate a long course of appreciable heat, and form important elastic and soluble aliments for absorption by the spongioles; yet in dry seasons, and in the manner in which they are commonly used, they have been found to attract vermin, create dry mould, and entail a considerable amount of evil. The farmers of Kent and Berkshire and Oxfordshire, usually cut them by means of a chopper and block into shreds of about one or two inches square, and spread them on their fields by hand, out of a common seed basket; and when the rags are applied in this way, they serve suitably enough either as a top-dressing on young grasses, or as an inhumed manure so ploughed in with one furrow as not to be pulled above ground by the harrows. But, in general, they would do far better to be specially prepared. "An excellent preparation," says Mr. Donaldson in his Treatise on Manures, "has been effected by steeping them chopped in small pieces in privies or urine pits; and they may then be applied to any crops. When chopped small and laid in drills for turnips, potatoes, and beet, they failed by 30 per cent. against farm-yard dung. The barley and hay crops showed a difference for a time after brairding, as often happens with such manures, but none at the time of reaping. It was curious to observe the dark green colour of the artificial grasses during winter and spring, till the growth commenced, when the difference soon vanished." But one of the best ways of preparing woollen rags, so as to effect uniformity of distribution, and to make them speedily or duly available for the nutrition of crops, and to draw from them a sufficiently rapid supply of food during the vigorous or hungry period of the growth of quickly growing crops, is to cut them into pulp by the rag-cutting machinery of a paper-mill, and to run the pulp of them immediately into a heap of earth, and form it into a compost. The quantity of rags apportioned to any field or to an acre cannot at present be reduced to any rule, and will in practice be very much determined by the abundance and the expense of them as compared to those of other suitable manures. A full supply of them can seldom or never be had; though, when their value becomes better known, they will be more carefully collected, and will either fall in price or rise in demand. An extensive dealer in them informed Mr. Cuthbert Johnson, a number of years ago, that at least 20,000 tons were then annually consumed by the farmers of the South of England; and some writers allege that the average quantity in which they are applied amounts to about 13 cwt. per acre. "Twenty-five cwt. per acre of woollen rags," says Boussingault, "the cost of which in France may be about £3, has been found sufficient as manure for 3 years. The slowness with which wool decomposes, indeed, causes its action to be continued during 6 or 8 years. Twenty-five cwt. of woollen rags may be held equivalent to upwards of 40 tons of farm dung, which at the price of 5s. 10d. per ton, would cost £11 13s. 4d. At the end of 3 years, M. Delonchamps, an excellent practical farmer, gives his land a dressing of farm dung for 3 years more, when he returns to the wool. Sinclair says that they are best suited for dry and sandy or chalky soil, and this because they attract moisture. I have not found the fact to be so. In the very dry soil of a vineyard, manured with this article. I have found the pieces to decompose with extreme slowness, and the effect upon the vines for a very long time to be scarcely perceptible." See the article Hop.

RAGWORT. See Groundsel.

RAIL. See Corn-Crake and Water-Rail.

RAILING. See Paling.

RAIN. This meteorological phenomenon depends upon the formation and dissolution of clouds. The humidity suspended in the atmosphere is derived from the evaporation of water, partly from land, but chiefly from the vast expanse of the ocean. A surface of lake, of pasture, corn-field or forests supports a continual evaporation, augmented only by the dryness of the air, and the rapidity of its successive contacts. Even ploughed land will supply nearly as much moisture to the atmosphere as a sheet of water of equal dimensions. If the whole of the waters, which fall from the heavens, were to return again, the evaporation from the ground might be sufficient alone to maintain the perpetual circulation. But more than one third of all the rains and melted snows are carried by the rivers to the ocean, which must hence restore this continued waste. The air, in exhaling its watery

store, is rendered quite damp; but it may afterwards become dry, on being transported to a warmer situation. Such is the case with the sea-breeze, particularly in summer. It arrives on the shore cold and moist; but as it advances into the interior of the continent, it grows milder and drier. The moisture deposited by a body of air in minute globules, which remain suspended or subside slowly in the atmosphere, constitutes a *cloud*. When it comes near us, whether it hovers on the tops of the hills or spreads over the valleys, it receives the name of a *fog*. The production of rain has, from the earliest times, engaged the attention of philosophers; but it was reserved for Dr. James Hutton, of Edinburgh, to afford the true solution of the problem. His theory of rain was made known in 1787; since which period it has been greatly neglected by writers upon meteorology, until within a very few years. We shall now give an outline of Dr. Hutton's views. Air, in cooling, it is known, has the property of depositing the moisture it contains. But how, it may be asked, is it cooled in the free atmosphere, unless by the contact or commixture of a colder portion of the same fluid? Now the portion of air which is chilled must, in an equal degree, warm the other. If, in consequence of this mutual change of condition, the former be disposed to resign its moisture, the latter is more inclined to retain it; and, consequently, if such opposite effects were balanced, there could on the whole be no precipitation of moisture. The separation of moisture, on the mixing of two masses of damp air at different temperatures, would therefore prove, that the dissolving power of air suffers more diminution from losing part of the combined heat, than it acquires augmentation from gaining an equal measure of it; and, consequently, this power must, under equal accessions of heat, increase more slowly at first than it does afterwards, thus advancing always with accumulated celerity. The quantity of moisture which air can hold, thus increases in a much faster ratio than its temperature. This great principle in the economy of nature was traced by Dr. Hutton from indirect experience. It is the simplest of the accelerating kind, and perfectly agrees with the law of solution, which the hygrometer has established. Suppose equal bulks of air in a state of saturation, and at the different temperatures of 15 and 45 centesimal degrees, were intermixed; the compound arising from such union will evidently have the mean temperature of 30°. But since, at these temperatures, the one portion held 200 parts of humidity, and the other 800, the aggregate must contain 1,000 parts, or either half of it, 500; at the mean or resulting temperature, however, this portion is only capable of suspending 400 parts of humidity, and, consequently, the difference, or 100 parts, amounting to the two hundredth part of the whole weight of air, must be precipitated from the compound mass. In this example, it has been assumed that the portions of differently heated air were saturated with moisture before mixing; but it is only required that they should approximate to this condition. The effect, however, of simple commixture would, in most cases, be very small. To explain the actual phenomena, we must have recourse to the mutual operation of a chill and of a warm current driving swiftly in opposite directions, and continually mixing and shifting their surfaces. By this rapidity, a larger volume of the fluid is brought into contact in a given time. Suppose, for instance, the one current to have a temperature of 50°, and the other that of 70° Fahr.; the blending surfaces will therefore assume the mean temperature of 60°. Consequently the two streams throw together 200 and 334·2 parts of moisture, making 567·1 parts for the compound, which, at its actual temperature, can hold only 258·6 parts; the difference, or 8·6 parts, forms the measure of precipitation, corresponding to the 2325th of the whole weight of the commixed air. It would thus require a column of air 30 miles in length to furnish, over a given spot, and in the space of an hour, a deposit of moisture equal to the height of an inch. If the sum of the opposite velocities amounted to 60 miles an hour, and the intermingling influence extended but to a quarter of an inch at the grazing surfaces, there would still, on this supposition, be produced, in the same time, a fall of rain reaching to half an inch in altitude. These quantities come within the limits of probability, and agree sufficiently with experience and observation. But in the higher temperatures, though the difference of the heat between the opposite strata of air should remain the same, the measure of aqueous precipitation is greatly increased. Thus, while the mixture of equal masses of air, at the temperatures of 40° and 60°, is only 6·6, that from a like mixture of 80° and 100° amounts to 19. This result is entirely conformable to observation, for showers are most copious during hot weather and in the tropical climates. The quantity of rain precipitated from the atmosphere, thus depends upon a variety of circumstances,—on the previous dampness of the commixed portions of the fluid,—their difference of heat,—the elevation of their mean temperature, and the extent of the combination which takes place. When the deposition is slow, the very minute aqueous globules remain suspended, and form clouds; but if it be rapid and copious, those particles conglomerate, and produce, according to the temperature of the medium through which they descend, rain, mist, snow, or hail. The foregoing theory tallies precisely with what we experience in the connexion of rain with the variable nature of the winds. Steady dry weather is always accompanied by a steady direction of the wind; whereas, in rainy weather, the winds are unsteady and variable. The heavy rains that fall in India always take place during the shift-

ing of the monsoons; and while they last, the winds are always veering.—The annual quantity of rain is greatest at the equator, and gradually diminishes as we approach the pole. This will be evident from the following table, showing the annual depth of rain in different latitudes.

	Lat. N.	Fall of Rain.
Grenada,	12°	126 inches.
Cape François,	19° 46′	120 "
Calcutta,	22° 23′	81 "
Rome,	41° 54′	39 "
England,	50° to 55°	31 "
Petersburg,	59° 16′	16 "
Uleaborg,	65° 1′	13½ "

On the contrary, the number of rainy days is smallest at the equator, and increases in proportion to the distance from it. From north latitude 12° to 43° the mean number of rainy days is 78.

From 43° to 46° the mean number is	103
" 46° " 50° " " " "	134
" 50° " 60° " " " "	161

Hence it is obvious that the rain falls in very heavy showers in warm climates, and that it becomes more and more gentle as we advance towards the pole. Consequently, in hot climates, the air must be much less loaded with moisture, and the rate of evaporation much greater than in cold climates. For when rain falls very heavy, a great portion of it runs off by the surface, and flows into the sea. But this happens to a much less extent when the fall of rain is more gentle.

RAIN-GAUGE, or PLUVIOMETER. A machine for measuring the quantity of rain that falls. There are various kinds of rain-gauges: one of the best is a hollow cylinder, having within it a cork-ball attached to a wooden stem, which passes through a small opening at the top, on which is placed a large funnel. When this instrument is placed in the open air, in a free place, the rain that falls within the circumference of the funnel will run down into the cylinder, and cause the cork to float; and the quantity of water in the cylinder may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated as to show, by its divisions, the number of perpendicular inches of water which fell on the surface of the earth since the last observation. It is hardly necessary to observe that, after every observation, the cylinder must be emptied. A very simple rain-guage, and one which answers all practical purposes, consists of a copper funnel, the area of whose opening is exactly ten square inches. This funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 173, which gives the depth in inches and parts of an inch. In fixing these gauges, care must be taken that the rain may have free access to them. Hence the tops of buildings are usually the best places. When quantities of rain, collected in them at different places, are compared, the instruments ought to be fixed at the same heights above the ground at both places, because, at different heights, the quantities are always different, even at the same place.

RAJANIA. A genus of tropical plants, of the yam family. Three species, all summer-blooming climbers, with herbaceous coloured flowers, and varying in height from 7 to 24 feet, have been introduced to Britain; but are interesting only to botanists. The name was formed in honour of the distinguished British naturalist Ray.

RAKE. A toothed implement for gathering hay, gleaning stubbles, pulverizing small beds of soil, covering small garden seeds, and several other kindred purposes.

The corn-rake varies in size and structure in different counties; but, in most cases, is a more or less simple drag-implement with iron teeth. "The head of the corn-rake," says an article in the Quarterly Journal of Agriculture on Reaping with the Scythe, "should be made of fine ash as light as possible, but strong enough to bear the driving in of a number of iron teeth; and it should be at least 5 feet in length, and feruled with iron at both ends. The teeth should be 7 inches in length, and 4 inches apart, and so curved at their point as that the weight of the rake may rest upon the curve, with their points free of the ground, when the rake is held in a working position. The points of the teeth should be thin and broad. The shank of the rake may be of light fir, and fully 6 feet in length. An iron rod passing from the shank on each side to the head, will prevent the latter being twisted out of its post. A short handle, like the left handle of the scythe, and fastened at a convenient spot on the shank with an iron wedge, will facilitate the passage of the rake over the ground."

"The drag-rake, in its simplest form," says Mr. Ransome, "is merely a long cross head, with a row of teeth placed in it; in some these are straight; they are, however, generally bent, with their points projecting forward. A very excellent and light implement, having the teeth of steel, and made with screws, so as to admit of being easily replaced in case of accident, is well known as Badgley's improved drag-rake. These rakes have, from time to time, increased in length and weight, till they became too large to be balanced by the hand. Two small wooden wheels were then added, which rendered them manageable by women or boys. Further addition having been made to them, they are now sufficiently strong to be worked by a horse. Used on fallows when foul, to remove the couch grass, they act as a harrow, to get together the rubbish, or in harvest time they act as a rake to collect the loose corn which may have escaped from the scythe or sickle. In order to clear them readily, there are different contrivances; one of the most simple and efficient of which is such, that by lifting the handle the teeth are brought between two iron bars, which constitute part of the frame, by which means all the rubbish is stripped off from the teeth of the rake."

The hand hay-rake, and the most important kinds of horse-rake for either hay or corn, are noticed in the article HAY-RAKE.—The garden iron rake is a very simple yet very important implement, of various sizes.—The drill rake is a large-headed rake with triangular teeth, like small coulters, set at 6 or 9 or 12 inches' distance according to circumstances; and is drawn across prepared beds or ridges to form drills for planting maize or saffron, or for sowing field crops of onions, carrots, or similar small-seeded crops.—The lawn or daisy rake has teeth closely set to one another, and sharpened on both edges like lancets; and is used for tearing off the buds and flower-heads of daisies and other intruding plants on lawns.

RAKING, or BACK-RAKING. The removing of hard fœces from the rectum of the horse with the hand. It is a useful operation in cases of constipation accompanying fever or inflammation; and ought, in all such cases, to precede the injection of clysters. A boy with oiled hand and arm performs it best; but he must be a steady lad, and should proceed slowly and cautiously.

RAM. An entire male sheep,—called in Scotland a tup. Rams, except at particular seasons, must be kept constantly separate from the rest of sheep stock, and even ought not to be within reach of their smell. See the articles SHEEP and BREEDING.

RAMOON-TREE,—botanically *Trophis*. A genus of ornamental, tropical, ligneous plants, of the wild olive tree family. Two species, both green-flowered evergreens of between 20 and 30 feet in height, loving a soil of loamy peat and propagable from cuttings, have been introduced to British collections; and some others are known. They are of some use to cattle in their native country, and hence received the name of trophis, which signifies fodder.

RAMPION,—botanically *Phyteuma*. A genus of ornamental herbaceous plants, of the bellflower order. One species grows wild in Britain; about 30 species have been introduced from other countries; and several more are known. The great majority are hardy and perennial-rooted, and have a height of between 6 and 24 inches, and carry blue or violet flowers in summer, and love a soil of peaty loam, and are propagated by division of the root, and do well for either rockwork or the flower-border or small pots.

The indigenous species, or round-headed rampion, *Phyteuma orbiculare*, occurs on pastures and on the sides of roads in some of the chalk districts of England, but is rare. Its root is woody and long, and divided at the crown; its stem is solitary, simple, smooth, angular, leafy, and commonly about a foot in height; its radical leaves are cordate or elliptico-lanceolate, and its cauline ones crenate, and all smooth and reticulately veined; and its flowers come out in a round head, with several leafy bracts, and are sessile, inodorous, and numerous, and have a violet or exceedingly brilliant deep blue colour, and bloom from June till August.

The spiked rampion, *Phyteuma spicatum*, has sometimes been used as an article of food. It is a native of Continental Europe, and was introduced to Britain toward the close of the 16th century. It differs from all the other species in having white-coloured flowers; and it usually attains a height of about two feet, and blooms from June till August.

RAMPION (GERMAN). See ŒNANTHE.

RAMPIONS, or RAMPION BELLFLOWER,—botanically *Campanula Rapunculus*. An indigenous, biennial, ornamental, and culinary plant, of the bellflower genus. See the article BELLFLOWER. It was formerly cultivated for sake of its esculent, tuberous root, but has, in a chief degree, ceased to be in request. It may, when wanted, be raised from seed sown in March or April, on a shady border, either broadcast or in drills 6 inches apart. The young plants must be thinned out to distances of 6 inches from one another in May; and the root will be fit to draw in the following autumn, winter, and spring.

RANDIA. A genus of ornamental, evergreen, white-flowered, tropical shrubs, of the madder tribe. Seven or eight species, varying in height from 5 to 15 feet, have been introduced to the hothouses of Britain; and all love a soil of loamy peat, and are propagated from cuttings. The prickly species, *R. aculeata*—called by some botanists *Gardenia randia*—is the tallest and one of the best known of the introduced species, and was brought to Britain upwards of a century ago from the West Indies. The stem is shrubby, and has a whitish bark, and rises to the height of from 10 to 15 feet; the branches come out oppositely from the sides of the stem, in such a way that each pair crosses the other; the leaves come out by pairs on short footstalks, and are thick, a little indented at the top, and about an inch long and three-fourths of an inch broad; two short spines stand oppositely at the joints immediately under the leaves; the flowers come out from the side of the branches, and are small, tubulous, and five-parted, and bloom from May till September; and the fruit are oval berries, about the size of marbles, with a brittle shell under a thin skin, and containing many compressed seeds within a black pulp.

RANUNCULUS. A large genus of ornamental, herbaceous, exogenous plants, constituting the type of the order Ranunculaceæ. This order stands at the head of the dichlamydeous division of exogens, or those which have both a calyx and a corolla,—of the thalamiflorous subdivision, or those which have the petals and the stamens inserted into the receptacle,—and of the first section of that subdivision, or those which have the carpels numerous, or the stamens opposite the petals. It at present comprises, within the gardens and botanical collections of Britain, 8

or 9 stove species, about 20 greenhouse species, nearly 50 hardy ligneous species, and about 600 hardy herbaceous species; and it is divided into five tribes,—the Ranunculeæ, the Anemoneæ, the Helleboreæ, the Clematideæ, and the Pæoniaceæ, comprising respectively four, six, eleven, three, and five genera. It naturally ranges over by far the greater part of the world; but is particularly abundant throughout most of Europe, and in some of the temperate parts of Asia. Its genera differ very widely from one another in external appearance, and in many of the most obvious botanical characters, yet are all at one in the essential characters of their fructification. The majority are objects of great interest to gardeners and florists; and many rank among the most brilliant and showy and beautiful flowering plants in the world; and a large number occur on the open border of every tolerably good flower-garden, or sometimes on even the most common cottage parterres. All, however, are as remarkable for their dangerous acridity as for their pleasing beauteousness; and not a few are very powerfully caustic and venomous. The crowfoots of our European pastures and the *Anemone trilobata* and *triternata* of those of South America, are well known poisons of cattle. The foliage of the acrid crowfoot is used by the inhabitants of Iceland for making blistering plasters; and that of some species of Clematis is supposed to afford the means employed by beggars of producing artificial ulcers. Some of the aconites, the crowfoots, and the hellebores figure in the pharmacopœias as very powerful medicines; and several of them are known also in the arts, either furtively or otherwise, as mightily active or mischievous agents. A species of nigella, too, is celebrated in ancient housewifery for its aromatic seeds, which were used in the same way as pepper now is; and a species of larkspur is said to be an ingredient in certain French cosmetics which act destructively on the surface of the skin. Yet the peculiar active principle of the Ranunculaceæ is of so very singular a nature as to be destructible only or at least chiefly by air and water; it is neither acidous nor alkaline; it acquires increase of power from mixation with sugar, honey, wine, alcohol, or acids; and it is so very volatile, or passes so very facilely into the atmosphere or into water, that, in most instances, simple drying in the air or simple infusing in water is sufficient to expel it. The principal medicinal properties of the officinal Ranunculaceæ are diuretic, sedative, emmenagogue, and violently cathartic or drastic.

The genus ranunculus is very broadly distinguished by the physical characteristics of the order, both floral and chemical. The genera which it represents as the type of the tribe Ranunculeæ are ranunculus, myosurus, ficaria, and ceratocephalus. Its calyx is five-leaved; its corolla is five-petalled, with a melliferous pore within the claws; and its seeds are naked. Seventeen species of it grow wild in Britain; upwards of 50 species have been introduced from other countries; and about 100 other species are known. Most of its species naturally inhabit moist places; and, in fantastic allusion to this circumstance, it obtained the name of ranunculus, from a Latin word signifying a frog. One very large subgenus of it consists principally of erect terrestrial perennials, and has fibrous roots, white or yellow flowers, and smooth, ovate, roundish carpels, disposed into a round head; another and much smaller subgenus, consists of terrestrial perennials, and has grumose roots, generally though not universally yellow flowers, and smooth carpels, disposed into a close spike; a third and still smaller subgenus consists of annuals, and has yellow flowers, and rough, tuberculous, or prickly carpels; a fourth and yet smaller subgenus consists of aquatic perennials, and has white petals, a yellow claw marked with a nectariferous hollow, and a transversely striated pericarp; and a fifth and smallest subgenus consists of terrestrial perennials, and has grumose roots, yellow flowers, and smooth subglobose carpels. All the species in Britain are herbaceous; all, except two or three, are hardy; most have a height of between 4 and 15 inches; very many deserve a place on the flower-border; some are among the most common of our wild flowers; and the majority thrive in any common soil, and are readily propagated by radical division. The indigenous species are noticed in the article Crowfoot; and only one of the exotic species, incomparably the most brilliant, and every way worthy to concenterate in itself the main floral interest of the whole genus, must form the subject of the sequel of the present article.

The Asiatic or common garden ranunculus, *R. asiaticus*, was introduced to Britain from the Levant toward the close of the 16th century. It is often called par excellence the ranunculus, as if there were no other; and it comprises a countless number of varieties and subvarieties, with double and semi-double flowers, of every hue from a creamy white to the deepest crimson, nearly approaching to black, and, in many instances, so beautifully variegated with streaks and dots and different markings as to rival the most superb picotees and carnations. Its root is grumose; its stem or stems are commonly about 9 inches high; and its leaves are trifoliate and twice trifoliate, with cut and trifid lobes. Two typal or fundamental forms of its multitudes of varieties occur,—the blood-coloured, *R. a. sanguineus*, with scarlet flowers, and originally from Syria,—and the fine-lobed, *R. a. tenuilobus*, with white flowers, and originally from Greece; but the varieties or subvarieties themselves cannot easily be classified, and almost defy enumeration. Any variety, if well treated, is supposed to be capable of lasting during from 30 to 40 years; but few or none, no matter how well treated, live vigorously or even live at all be-

yond that period; and some, or perhaps most, are liable to a very speedy extinction by bad keeping, hot manuring, or other improper treatment. Lamentations have for many years past prevailed, that the ranunculus has sadly degenerated, and has become exceedingly difficult of culture, and deplorably liable to failure; and nostrums many and intricate have been propounded by all sorts of amateurs for reviving it, or for obtaining sure and beauteous blooms, by means of curious manuring or of novel methods of culture. But if the varieties be new enough, and the time of planting suitable enough, and the soil consolidated and cool enough, and at the same time free from stimulating or unduly strong manure, no apprehension need be entertained that blooms of this most gorgeous flower will be obtained as good and certain as before the cry of degeneracy was raised.

The following directions for cultivating the ranunculus were transmitted to England a few years ago by M. Tripet le Blanc of Paris, one of the best ranunculus growers in France: and are perhaps as good as any which can be given:—The bed, which should be made in November or December, need not be more than a foot deep, and it should have an eastern exposure. The soil should be equal parts of fresh turfy loam and old cow-dung, or thoroughly rotten leaves, and these should be well mixed together by turning the mass over several times with the spade. The bed should be raised 3 or 4 inches above the level of the walks, to allow for its sinking. In the first week of February the tubers are to be planted, when strings should be stretched across the bed in slanting lines, 4 inches apart, so as to intersect each other like network; and drills should be formed under the strings an inch and a half deep. The tubers should then be put into the ground, one being planted at every point where the lines meet, and the earth should be drawn over them. Care should be taken never to cover the tubers more than an inch and a half deep; and it is better for the covering to be less rather than more. The tubers should be planted with their claws downwards, and the beds should be regularly watered whenever the weather is dry. The advantage of making the bed in November, and not working it at all when the tubers are planted in February, is that the soil has had time to settle, so as to afford a firm bed, which is advantageous, as the ranunculus never thrives in a loose soil; and by planting the roots in spring, they are saved from the danger of injury from cold and wet during winter. In England the bed is generally made two feet deep, and a layer of two years' old cow-dung, 6 or 8 inches deep, is placed at the bottom, the bed being filled up, and raised about 5 inches above the surface, with a fresh and strong loam, and the roots are planted in November, covering them 10 or 15 inches thick with straw during the frosty weather."

IV.

RAPE. Several species and varieties of cruciferous plants, of the turnip and cabbage genus, cultivated for the expression of oil, the feeding of cattle, and some other economical purposes.

Kinds of Rape.—The summer rape, cole, colsa, colza, or wild navew culsat, *Brassica campestris oleifera*, is noticed in the article Cole. The name of summer rape, given to this kind, refers to its arriving earlier at maturity than the common or winter rape, and also alludes to its being less capable of withstanding severe winters, and therefore more suitable to be grown for a summer or autumn crop than for a spring one.

The common rape or winter-rape or cole-seed, *Brassica napus*, occurs in a wild state in ditches and banks and borders of corn-fields of some parts of England. Its root is biennial, tapering, woody, and hard; its stem commonly attains a height of about two feet; its leaves are smooth, glaucous, and thickish or somewhat fleshy; its radical leaves are lyrate; its cauline leaves are clasping, notched, and pinnatifid; its flowers are yellow, and naturally bloom in May; and its seeds are similar to those of the Swedish turnip, and are sometimes smaller and sometimes larger than those of the summer rape, and are much controlled in size by the influences of soil and culture. This plant, in a growing state, is most readily distinguished from the summer rape by the smoothness of its leaves, and the comparatively deep and obscure yellowness of its flowers. But three very distinct varieties of it are in cultivation,—the oil-bearing, the greater, and the esculent, *B. n. oleiferus*, *B. n. major*, and *B. n. esculentus*,—the first and the second field plants, for oil and rape-cake and fodder, and the third a garden plant, for salads and other culinary purposes; and three permanent subvarieties of the last, also, are in cultivation,—the white, the yellow, and the blackish, *B. n. e. albus*, *B. n. e. flavus*, and *B. n. e. nigricans*. The greater variety, *B. n. major*, has comparatively large leaves, and is much cultivated in Alsace, and deserves special attention from farmers who raise the rape plant for fodder.

The early rape, annual rape, smooth-leaved summer rape, or early kohl-reps, *Brassica præcox*, is a native of Continental Europe, and was introduced to Britain in 1812. Its root is annual; its stem is about two feet high; and its stem-leaves are more lyrate, and its seed-pods more erect, than those of the common rape. It produces a smaller amount of herbage, and is less oleiferous, and has less power of resisting frost, than the field varieties of the common rape; yet, in consequence of its running to seed much sooner than these varieties, it might probably be found to succeed corn-crops with more advantage than they in Scotland and the northern parts of England.

The turnip rape or rough-leaved summer rape, *Brassica rapa*, occurs in a wild state in the corn-fields of some parts of England. It may be re-

garded as either the original and normal form of the common turnip, or as a group of all the varieties or subvarieties of that species which have fusiform roots; and it is either annual or biennial according to the season of the year in which it is sown. Its root is comparatively small and hard; its stem is about two feet high; its radical leaves are lyrate and vivid green, and have none whatever of the glaucous bloom which distinguishes the preceding kinds of rape and the many varieties of cabbage; and its cauline leaves are slightly glaucous and quite or nearly smooth, —and the lower ones are generally lobed or cut, and the upper ones almost entire.

The elongated or Hungarian rape, *Brassica elongata*, is a native of Hungary, and was introduced to Britain in 1801. Its root is biennial; its stem is smooth and between 3 and 4 feet high; its radical leaves are stalked, pinnatifid, sinuate, and hispid; its upper leaves are stalked, toothed, and smooth; its flowers are yellow and naturally bloom in May and June; and its pods are raised on short pedicels above the receptacle. This rape produces a smaller bulk of foliage than the summer and the winter rapes, and therefore is less adapted to be grown for forage; but it is said to yield a much larger quantity of seeds, and it is cultivated on account of these in its native country.

Garden Cultivation of Rape.—Rape, as a salad herb to be gathered in the seed-leaves, may be sown at any time of the year when it is wanted, and must be raised, in a separate bed, in the same manner as mustard and garden cress. Plants intended for seed should be selected from a sowing made in the latter part of June or in July, and must be thinned out to distances of about 15 or 18 inches; and they will bloom in May and June of next year, and mature their seeds in July and August. But due precaution must be used that no other brassica is going to seed in their neighbourhood, else they may egregiously fail to propagate their true or typal character. See the article Brassica. The ripe plants, too, should be carefully cut and laid upon cloths to dry, or they are very liable to shed their seeds.

A variety of rape, called the edible-rooted, may be cultivated in the garden for the sake of its root. It has long been cultivated on the Continent, and has been known for many years to a few persons in Britain, and is recommended to general notice in the Transactions of the London Horticultural Society. Its root is white, and carrot-shaped and about the size of the middle-finger, and very thin-skinned; and it has a much more delicate flavour than the turnip, and is cooked in the same manner as that root, except that it is only scraped and not peeled. It is cultivated in the same way as the turnip; but it requires no manure, and may be produced at almost any period of the year. Any soil of a light and poor kind, especially if decidedly silicious, is very suitable for it; and a richly manured soil will cause it to grow much larger, but will correspondingly impair its sweetness and delicacy. The main crops may be sown from the middle of June till the end of August, and will afford supplies of the root till April; a secondary crop may be sown in the latter part of October, to afford supplies in April and May; and crops may be sown on a warm border in January and February,—and again, on a moist north border from the latter part of March till May,—to keep up a succession of supplies throughout spring and summer. But the winter-growing crops are precarious; and the spring and summer-growing crops, from the time of sowing till they get three or four leaves, must be regularly watered in dry weather. Plants intended for seed must be selected in February or March, and either transplanted to distances of two feet from one another, or thinned out and left standing at these distances; and the ground around them must be kept clear of weeds and repeatedly hoed.

Field Cultivation of Rape.—The field rapes most suitable for being fed off with sheep, or for the soiling of cattle, occupy the same place in a regular rotation as the turnip or the potato, and serve excellently, in the former case, as a first crop on newly reclaimed land or on broken-up old grass land, and are also a valuable substitute for the turnip on arable lands which are too wet and heavy for that root. They succeed on most kinds of soil, and do well for a change upon ordinary or prime turnip soils, but are most partial to strong alluvial loams, to rich clays, and to lands of firm and good quality which have been long in grass. If grown on poor land, indeed,—especially if allowed to stand too thick,—rape has a small and woody stem, and is liable to be mildewed, and will generally be disrelished by stock and unprofitable to the owner; but when grown on clean and well-tilled land, and when properly cultivated,—and especially when rightly raised on well-conditioned aluminous soils,—it is generally luxuriant, and has a succulent stem and a sapid foliage which all sheep relish, and excels most field plants in escaping the attacks of insects and fungi, and in resisting the vicissitudes of the weather.

The cultivation of rape as an herbage plant on lands already under tillage differs little from that of the turnip. The land should be cleared of weeds and minutely pulverized by repeated ploughings and harrowings. On light soils, in the absence of farm-yard manure, bone dust may be advantageously employed, the quantity being the same as for a turnip crop. When rape is sown for the purpose of being eaten off with sheep, both the broadcast and drill systems are adopted; but when intended to be cut for feeding cows or other cattle in the house, the drill system is preferred. In every case, however, the drill system is preferable, as admitting the operations of hoeing and weeding to be performed with much greater facility and ex-

pedition. When sown in drills, from 3 to 4 pounds of seed per acre will be sufficient; and when broadcast, from 8 to 10 will be necessary. The time of sowing is from the middle of July till the middle of August. Rape succeeds well by being transplanted. By taking advantage of this property two crops may be got off the land in a season. For this purpose the seed is sown in beds in the garden, or in any other convenient spot at the usual time, and planted out as soon as possible after the grain harvest is secured; but this plan can only be adopted where the land is dry and where a green crop is to succeed. The stubble will be sufficiently pulverized under ordinary circumstances by a single ploughing and harrowing, and the plants may be drilled in rows 18 inches apart,—6 inches in the row, or narrower, according to the lateness of the season of planting and the quality of the soil. The method of transplanting rape in the Netherlands, where it is extensively cultivated, is to lay the plants at the regular distances on the newly turned up furrows in ploughing, and they are covered by the next furrow, and so on till all is planted. This plan has been partially introduced into England and Ireland; but planting by the dibble is to be preferred, as any advantage gained in the saving of time in the Flemish mode is more than counterbalanced by the loose and insecure way in which the plants are necessarily deposited. It cannot be expected that the crop under these circumstances will be as luxuriant as when sown in a proper season and the growth not checked by transplanting. This method of growing it is valuable only as securing a crop when the land would otherwise be unproductive; and if it be consumed on the land, a valuable and permanent improvement will be effected. The after cultivation in any case is the same as that of the turnip, and consists in weeding, hoeing, and thinning.

The crop may be cut down and given to cattle in the stalls, and a second cutting will be produced; but the better method of consumption seems to be to eat it down occasionally, with sheep on the land. The crop is commonly fed off at intervals from the beginning of November, until the middle of April, being valuable at the former period for fattening ewes, and at the latter for supporting ewes and lambs. Rape with a thick stem and in a luxuriant state is eaten with great greed and high relish by all sheep, and very rapidly fattens them; and, on good land, it may, in most instances, be readily worked or coaxed into this state by the very free use of the horse-hoe. Pithy, succulent, strong stems, in fact, are evidently better liked by sheep than the foliage, and may therefore be supposed to contain more nourishment, or at any rate to possess high adaptation to healthy and vigorous winter feeding. Some farmers even raise rape for the use of stock throughout a large portion of autumn, and obtain a regular succession of it by means of three several sowings between the middle of May and the end of June, and usually put their sheep upon it about three months after it has been sown, and afterwards sow the land with winter wheat. A considerable quantity of the very best food is thus produced during a period when it is greatly wanted, that is, from the time when the freshness of the clover and the grass leys is on the decline till the time when the turnips become fully grown; and this is considered equally valuable for the lambs when taken from the ewes, and for the shearing wether sheep 18 months old, which at that period are nearly fat and require food of the most nutritious kind.

Any land which has been cropped with winter rape, and fed off in winter or in spring with sheep, provided due culture has been given and no extraordinary wetness of weather have prevailed, is in a state of very high amelioration. It has lost absolutely nothing by the crop; and it has gained a great deal by the fallowing agencies of the culture, by the fixation of atmospheric gases, by the treading of the sheep, and by the deposition of their excrements. "Whatever be the succeeding crop," remarks Mr. Rham, "it cannot fail to be productive; and if the land is not clean, the farmer must have neglected the double opportunity of destroying weeds in the preceding summer and in the early part of spring. If the rape, supposing it to have been sown about the beginning or middle of August, be fed off in time, it may be succeeded by barley or oats with clover or grass seeds, or potatoes, if the soil is not too wet. Thus, no crop will be lost, and the rape will have been a clear addition to the produce of the land." Even land which has been cropped with summer rape, and fed off with sheep in autumn, is, in some cases, as much improved by the process, and in a state of as high preparation for the immediately succeeding crop of wheat, as if it had been summer-fallowed; yet, in wet seasons, and under excessive poaching from the feet of the sheep, especially in cases where the soil is decidedly argillaceous, it is always more unfit for wheat, and will yield a considerably smaller or inferior produce of it, than if it had been summer-fallowed. The substitution of fed-off rape for summer-fallow, therefore, ought to be done with caution, and only in certain circumstances; though it has sometimes been so successful, as besides affording a clear gain of the whole rape crop, and yielding the great convenience of a timely and valuable supply of sheep-food, to render very inferior clay soils productive of excellent crops of wheat.

A main excellence of rape as a forage crop, viewed with comprehension of the several varieties of the plant and of their wide range of adaptation to soil and season, is its capacity to supplement or substitute any green or fallow part of any ordinary rotation. It may be sown in spring, in summer, or in autumn,—in preparation for a spring crop or in preparation for a

winter one,—at the commencement of a course of tillage in breaking up from lea, or at the close of a course of tillage in returning to lea,—as either a substitutionary crop, or an intermediate crop, or a principal one,—and either only once at a time, or twice or oftener repeated. When land cannot be prepared in sufficient time for the turnip, it is yet ready for a crop of rape; when land is in too ungenial a condition for some other intended green crop, it may be in a suitable enough condition for rape; when land has been prepared for summer-fallow, yet is intended to be reserved for oats or barley in the following spring, it may be cropped in the intermediate time with rape; when land has been under early pease or under potatoes, and is not fit to be sown with winter wheat, it may be cropped with winter rape; and even, in many instances, when land is in ordinary rotation of alternate white and green crops, it may be advantageously sown with rape upon the ploughed stubble, and eaten off with sheep in March and the early part of April. An experiment was tried, nearly 20 years ago, at Netherby in Cumberland, of sowing in July 120 acres of prime loamy land with rape in the laying down of permanent pasture. The ground was thoroughly cleaned and limed; the rape and the grass seeds were sown together; and, as soon as the rape arrived at the proper stage of maturity, it was eaten off by sheep. A report of the experiment 8 years after says that it succeeded, and that the land was then the best pasture in the country.

The cultivation of rape for the production of oil is a widely different affair from the cultivation of it as a forage plant. The most suitable varieties of it, as we showed in a former section, are different; and the effects upon the land are so exhausting, that the rape must take the place of a white crop in a rotation, and must not be repeated sooner than after an interval of 5 or 6 years. But it is not suited to the coldness and moisture of the west coast of England and of most parts of Ireland; and it commonly yields so slender or precarious a compensation in even the most favourable parts of Britain, as to be suitable only in extraordinary circumstances or as an occasional crop. In the fens of Lincolnshire and Cambridgeshire, as a first crop on broken up land which has been long in grass and is of prime quality, it usually yields so great a produce as from 40 to 50 bushels per acre of clean seed, and is generally found to be highly or sufficiently compensating; but on similar soils in other circumstances, or as a substitute for a white crop in the course of a rotation, it sometimes or often does not yield more than one-half of that produce, and is there, of course, of correspondingly small value. It may be sown, according to the variety and the situation, from the end of May till the end of August; it may be sown broadcast at the rate of half a peck of seed per acre, but will do much better to be drilled; it should receive the same after-culture as when intended for a forage crop until the season of its passing into flower and seed; and if very luxuriant, it may more than once be slightly pastured by lambs when they are first taken from the ewes. The crop must not be cut till fully ripe, or about the month of June; and it should be cut while the dew is on it, and moved as little and gently as possible. It so easily sheds its seeds in consequence of the lower pods being ready to burst before the upper ones are full, that, if not very carefully managed, especially in unfavourable weather, a considerable portion of the produce will be lost; and, if the state of the weather will at all permit, it ought at once and promptly to be thrashed out in the field. In some parts of the Continent, where an oil-mill exists on the farm, the seed is conveyed thither and bruised immediately after being thrashed; but in England, it is generally spread out on the floor of a granary, and frequently turned over, till it become dry, and is then sold to the crushers who express the oil. The straw is often burned in the field; but ought always to be carried to the farm-yard and used for fodder and litter. The smaller twigs or branches are greedily eaten by either sheep or cattle or horses; and the thicker portions of the stems, or such parts of the entire straw as remain after being picked over by the cattle, are readily converted in the form of litter or with the aid of swine into valuable manure.—*Lawson's Agriculturist's Manual.—Rham's Dictionary of the Farm.—Knowledge Society's Outlines of Flemish Husbandry. — Knowledge Society's Reports on Select Farms.—Communications to the Board of Agriculture.—Marshall's County Reports.—Irish Farmer's Journal.—The Gardener's Gazette. — Mill's Husbandry. — Dickson's Practical Husbandry.—Transactions of the Horticultural Society.—Mawe. Johnson.—Doyle.—Low.*

RAPE CAKE, or Rape Dust. The refuse of rape seeds after the expression of the oil. It originally forms a hard cake, but can at any time be readily reduced to powder. It is used on the Continent for feeding cows and pigs, in the same manner as linseed cake; and is much employed, both on the Continent and in Britain, as a rich or special manure. Large quantities of it are imported from the Continent into Britain; and are various in appearance and quality, and obtained partly from the seeds of the winter rape, but more commonly from those of cole. The best kind, when new or pretty recent, has a yellowish-green colour, but becomes darker when long kept.

Every cargo or large quantity of rape-cakes, ought, immediately on its arrival, if the weather be dry, or as soon after as dry weather occurs, to be stored in a warehouse on a dry floor, either wooden or earthen, and built up in heaps clear of the walls, so as not to draw damp from them; and the place should be kept as free as possible from the admission of humid air, or even from

the admission of any kind of air. If the cakes be new, they will heat a little; and if they have not had a due 'sweat' in the ship, or may be apprehended to be more than usually prone to heat, the broken and pulverized portion of them should be separated and kept by itself. Both the dealer and the large consumer who keep a quantity of rape in the shape of dust by them, ought never to fling it down in the corner of a cart-shed, or in any similar place, where it is exposed to the humidity of the air, and to the interference of pigs and poultry. However dry it may appear, and however free from liquid moisture it may be kept, yet, on being laid somewhat thick together, it will sooner or later heat, and may eventually form a large portion of its substance into lumps as black as soot and not much different in internal appearance from coal cinders. Any heap of rape dust which threatens to become heated, should be spread as thin as the space for it will permit, and now and then turned carefully over.

A chief value of rape dust as a manure depends on its comparatively large proportion of nitrogen, and consists partly in the contribution which that element makes to the feeding of a crop, and partly in the readiness with which it sets up decomposition, and generates heat, and communicates the fermentative action to other dead organic substances which are more reluctant to decay. According to analyses by Boussingault and Payen, normal cole-cake contains 4·92 per cent. of nitrogen, while normal farm-yard manure contains only 0·4 per cent.; so that, in everything which depends on the action of nitrogen, 8·13 cwts. of cole-cake ought to manure as much land as 5 tons of farm-yard manure. But rape-cake also exerts very considerable manurial power, both by contributing earthy phosphates in direct nutrition to crops, and by combining the action of various saline and organic principles in the fermentative process within the soil. According to a testing process by Dr. Madden, 100 parts of rape-dust dried at 212° Fahrenheit give off 10·5 parts of water; and of the remainder, 24·7 are soluble in cold water, 4·8 are soluble in hot water, 31·5 are soluble in weak potash, 10·2 are soluble in strong potash, 14·3 are destroyed by heat, 3·0 consist of earthy phosphates, and 1·0 consists of silicate of potash.

Mr. Hannam, in his Prize Essay on Rape Dust and other Hand-Tillages, states, as practical conclusions from his own experience, that rape-dust produces its most marked effects on thin poor soils,—that it operates more beneficially in a dry season than in a moist one,—that it is most certain in its effects upon winter-sown wheat-crops, but, in favourable seasons, most remunerative on the spring crops,—that it answers best on strong soils for wheat-crops,—that it cannot judiciously be applied in large quantities at one time,—and that, when used for several rotations, it requires to be followed by a top-dressing of saline and earthy matters. Most practical writers, however, say that it does better on moist soils than on dry ones, and better on any land in wet seasons than in dry ones; and the truth may be that it does best in its proper or unmixed state on dry soils and in dry seasons, and best in a state of large dilution or controlling intermixture with other substances on moist soils and in wet seasons. Its valuable and powerful tendency to set up or accelerate decomposition in other substances requires that it be mixed with them, and is mightily aided by the presence of moisture; and this very tendency, at the same time, endangers the killing and rotting of the crop-seeds, if it be deposited in direct or undiluted contact with them, and may, in that case, be rendered mild and innocuous by the comparative absence of moisture. It also decomposes too rapidly, and becomes wastefully dissipated, when subjected unmixedly to the action of moisture; so that, whenever it is applied to moist land, or likely to be exposed to moist seasons, it should either be combined with some other and far bulkier organic manure, or largely diluted with an intermixture of ashes or of some dry porous earth. It may be used likewise to strengthen a liquid manure with an urine basis, to modify and enrich an excessively ammoniacal liquid manure, to form an artificial liquid manure by solution in water with the addition of some urine, and to set up decomposition with great speed and with highly fertilizing result in a compost of peat or of any other inert vegetable substance. In most modes of application, it is supposed to be destructive to the majority of insects which infest the soil; and, in mixture with elder or wormwood, in particular, it is thought to be an antidote against the wireworm.

Rape-cake is commonly reduced to powder in a one-horse mill at the rate of 5 tons a-day. The dust or powder is applied either in the drill, or in broadcast sowing, or in the way of top-dressing; and it is commonly given at the rate of from 10 to 15 cwt. per acre for turnips, and at from 10 to 12 cwt. or less for clover or grass or grain crops. When applied in the drill method to wheat, it does best to be partly given at the time of sowing in autumn, and partly drilled into the spaces between the rows in March and April,—for if given wholly in autumn, it is apt to make the plants grow too strong and root-fallen; and when applied in the broadcast method, it requires merely to be sown and harrowed in with the seed of grain crops, or to be sown on grass or on the braird of grain without harrowing. But when diffused over the surface as a top-dressing, a great portion of it is wastefully dissipated in gaseous products of decomposition, some is carried off by birds, and more or less is appropriated by weeds. Its proper use as a main ingredient in liquid manure is somewhat peculiar. "It is probable," says Mr. Rham, "that the most advantageous mode of using it on the land, after it has been dissolved in the urine

tank, is to apply it by means of a water-cart to the rows where the seed has been already drilled, or some time before it is put in. Where flax is to be sown, this mixture applied a few days before the seed is sown, so as to allow it to sink into the soil, is considered in Flanders as next in value to the emptyings of privies, which with them hold the first rank, for producing fine crops of flax. When a crop appears sickly and not growing as it should do, owing to poverty in the soil, a top-dressing of rape-cake, dissolved in water if no urine is at hand, will generally excite the powers of vegetation; and it is highly probable that it may greatly assist the effects of saltpetre or of nitrate of soda, where these salts are applied."

RAPHANUS. See Radish.

RAPHIOLEPIS. See Indian Hawthorn.

RAPISTRUM. A genus of yellow-flowered herbaceous plants, of the cruciferous order. It takes its name from the similarity of its leaves to those of the turnip. Two annual species and a perennial one, all hardy and less than two feet high, have been introduced to Britain from Continental Europe and the Levant; but they possess little interest.

RAPUNCULUS. See Bellflower and Rampions.

RASPBERRY. The *Rubus idæus* of Linnæus, belonging to the order *Rosaceæ* of Jussieu, is indigenous to the moist woods of many parts of Britain. The styles being persistent, the fruit has a bristly appearance, from which the name *raspis* or rasp has been given. The fruit is very desirable both for the dessert, and for making jam, tarts, and sauces. Eaten fresh with cream and sugar, it makes an excellent supper-dish, and may be had from July to November.

The varieties chiefly cultivated are the following: the common red and common white, the large red Antwerp, the large yellowish-white Antwerp, the cane or smooth-stalked, also called reed raspberry, the twice-bearing white, the twice-bearing red, and the Barnet or Cornwall's seedling,—"a variety," says Rogers, "which being raised from seed, will no doubt be the forerunner of a host of others." Some still prefer the common kinds of red and white, thinking that an increase of size in the larger varieties has been purchased at the expense of flavour; but the new varieties are, upon the whole, to be accounted preferable. The second crop of the twice-bearing kind is in general deficient both in flavour and size; but, by means of it, the raspberry season is prolonged till the beginning of November. It is to be particularly noticed, however, that the fruit should be regularly gathered as it ripens, and should be almost immediately used after being gathered; it will remain good on the bush for a few days after being ripe, but a dish of raspberries kept in the house for two days, will generally be found to have lost flavour, and to be tainted by maggots.

Sucker-shoots rising abundantly afford plenty of plants; but they should always be taken from stools in full bearing. They are planted any time from October to February. The distance is seldom less than three feet between the plants, and the quincunx order is generally adopted, five feet being left between the rows. If the larger varieties be planted, the distances are increased. A raspberry plantation continues good for six or seven years; but after the lapse of that period, it should be entirely renewed; it is generally in perfection the third year after planting; so that a new raspberry quarter should be prepared two years before the old one be grubbed up.

During summer raspberry-plants receive little attention. The ground is repeatedly hoed, and a few of the superfluous suckers are sometimes removed. Before winter, the ground is commonly dug and left rough. In some places the stools are dressed at this season (November); and a slight crop of coleworts is put between the rows. If this be not done, the general pruning is deferred till February or March, when the decayed stems of the former year are cut out, and the new ones regulated and tied: for there is this peculiarity about raspberry-bushes, that the stems which bear fruit in one year die in the following winter; leaving in their place a succession of new stems, which have been produced during the summer. Where the stools are very strong, six or eight stems are allowed to remain; but in young or weak plants, only half that number are suffered to carry fruit. At the same time, the tender tops which have been injured by frost and hang down, are cut off. Plants pruned or dressed before winter, it may be observed, sustain most injury from frost; the old stems, when left, affording a degree of protection to the young shoots. In exposed situations stakes are found necessary for supporting the stems; but in general it is thought sufficient to twist the shoots loosely together, and to tie them at top with a strand of bass-mat. Sometimes, the tips of half the shoots on one stool are tied to half the shoots of the next; and in this way a series of festoons or arches is formed, producing a very agreeable appearance, and at the same time affording security against the highest winds.

The raspberry-bush grows freely in any good garden soil; but it is the better for being slightly moist. Although the place be enclosed by trees, and even slightly shaded, the plant succeeds. In an enclosed and well sheltered quarter, with rather a damp soil, containing a proportion of peat-moss, we have seen very great crops of large and well-flavoured berries produced. Sometimes a few plants are trained against a west wall, or a trellis or rail, and the fruit here comes more early and of larger size. By training against a north wall, the crop is proportionally retarded. New varieties of raspberry are easily raised from the seed; and they come to bear in the second year.

RAT. The common brown or Norway rat, now so extensively diffused over this country, was almost, if not wholly, unknown in Europe until the year 1750. It was conveyed to England about the period above mentioned, in the timber-ships from Norway; and hence it has received one of its common names. Many years subsequently it was conveyed to America in European ships, and has been gradually propagated from the seaports over the greater part of that continent also. The brown rat takes up its residence about wharfs, store-houses, cellars, granaries, &c., and destroys the common black rat and mouse, or entirely expels them from the vicinities it frequents. To chickens, rabbits, young pigeons, ducks, and various other domestic animals, it is equally destructive, when urged by hunger and opportunity. Eggs are also a favourite article of food with this species, and are sought with great avidity; in fact, every thing that is edible falls a prey to their voracity, and can scarcely be secured from their persevering and audacious inroads. In the country, they take up their abodes according to convenience and the abundance of provision, infesting especially mills, barns, and out-houses, or residing in holes along the banks of races or other watercourses. The brown rat swims with great facility, and dives with vigour, remaining under water for a considerable time, and swimming thus to some distance. When attacked, and not allowed an opportunity of escaping, he becomes a dangerous antagonist, leaping at his enemy, and inflicting severe and dangerous wounds with his teeth. The most eager cat becomes immediately intimidated in the presence of one of these rats thus penned up, and is very willing to escape the dangers of an encounter. The brown rat is amazingly prolific, and, but for its numerous enemies, and its own rapacious disposition, would become an intolerable pest. Happily for the world, in addition to man, to the weazel, cat, some species of dog, &c., rats frequently find destructive enemies in each other, both in the adult and young state. The strongest of the species prey upon the weaker, and are the most merciless destroyers of their own kind. The weazel and the terrier are the most efficient rat-killers, as the first can pursue the enemy to his most secret retreat, and the second derives, from his superior strength and activity, a very decided advantage in the contest. The cat, though in general a very useful auxiliary in lessening the number of this species, is very liable both to be foiled and worsted in her attempts. As these rats bring forth from twelve to eighteen at a litter, we have good reason to rejoice that so many animals have an instinctive animosity against so noxious a marauder. The cunning of these rats is not less than their impudence; it is almost impossible to take them in traps, after one or two have been thus caught, as the rest avoid it with scrupulous care, however tempting may be the bait it contains. The surest way to remove them is by some special poison, or by means of peculiarly scenting the traps. See the articles Vermin and Mouse. The powder of *nux vomica*, mixed with oatmeal, and scented with oil of rhodium, is sometimes effectual in destroying them. Arsenic is commonly used in the same way for this purpose; but the fatal accidents which frequently occur when this poison is kept about the house, in consequence of the label being removed or changed, render it a very objectionable resource. The brown rat measures about nine inches, and is of a light brown colour, intermingled with ash and tawny. The colour of the throat and belly is of a dirty white, inclining to grey. It has pale, flesh-coloured, naked feet, with a tail of the same length as the body, and covered with small dusky scales, with short hairs thinly scattered between.—The *black rat* was much more common previous to the introduction of the brown rat than at present. It is now found only in situations to which the brown rat has not extended, and is almost as injurious and destructive, resembling it closely in manners and habits. It is of a deep iron-grey, and indeed nearly of a black colour above, and of an ash colour on the lower parts of its body. Its legs are nearly naked, and on its fore feet, instead of the rudimental thumb, it has a claw. The length, from the nose to the root of the tail, is seven inches; the tail itself is almost eight inches long. Blumenbach, who has devoted much attention to the subject, states it as his opinion that the black rat also was carried from Europe to America.

RATANHIA ROOT. See Krameria.

RATH-RIPE. The property of early ripening.

RATTAN. See Calamus.

RATTANY. See Krameria.

RATTLE (Red). See Lousewort.

RATTLE (Yellow),—botanically *Rhinanthus*. A genus of ornamental herbaceous plants, of the figwort family. Two annual species grow wild in Britain; two yellow-flowered, summer-blooming, hardy annual species, of respectively 12 and 20 inches in height, have been introduced from Continental Europe, and a number of other species are known. The name rhinanthus signifies snout-flower; and both it and the popular name yellow rattle, are descriptive,—the former alluding to the form of the corolla, and the latter to the rattling noise made by the capsules when handled.

The common or cock's comb yellow rattle, *Rhinanthus crista-galli*, abounds in poor meadows and pastures in many parts of Britain. Its root is fibrous; its stem is quadrangular, smooth, leafy, scantily branched, frequently spotted with red or purple, and commonly about a foot high; its leaves are lanceolate, acute, sharply serrated, spreading, rough, wrinkled, and from 1 to 1½ inch long; and its flowers grow crowdedly on a terminal, bracteated spike, and have a yellow co-

rolla and a smooth, ribbed, bladdery calyx, and bloom from June till August. This plant is far more a weed than a member of the grass lands which it inhabits; and it is disliked by cattle, both in the green state and in the state of hay.

The larger or bushy yellow rattle, *Rhinanthus major*, grows in corn fields in various parts of Britain, particularly in the north of England. It is annual, and has commonly a height of about 3 feet, and blooms in July and August; and it has more abundant branches than the preceding, narrower leaves, and smaller yellow flowers, with a purple upper lip.

RATTLER. See Aspen.

RATTLESNAKE ROOT. See Milkwort.

RAUWOLFIA. A genus of curious, tropical, evergreen, ligneous plants, of the dog's bane order. Three species with white flowers, and one with pink flowers, all propagable from cuttings, and varying in height from 3 to 14 feet, have been introduced to British collections; and 8 or 9 more are known.

RAVEN. The largest of the crow-family resident in Britain. Its body is of an ovate form, rather bulky; the neck strong, and of a moderate length; the head large and oblong; the bill rather long, deep, and nearly straight; the feet of moderate length and ordinary strength. The plumage is compact and highly glossed; the wings long and much rounded; as is the tail. The bill and feet are black; the plumage deep black, with splendent reflections of rich purplish-blue. The length of the male is twenty-six inches, and its extended wings measure fifty-two.

The raven is a remarkably grave and sedate bird, and is equally noted for sagacity and prudence. It is crafty, vigilant, and shy, so as to be with great difficulty approached, unless in the breeding season, when its affectionate concern for its young, in a great measure, overcomes its habitual dislike to the proximity of man; a dislike which is the result of prudence more than a mere timidity; for, under particular circumstances, it will not hesitate to make advances which a timorous bird would deem extremely hazardous. It eats from off the same carcass as a dog, and takes its station close to an otter devouring its prey, doubtless because its vigilance and activity suffice to enable it to elude their efforts to inflict injury upon it; and while it yields to the eagle, it drives away the hooded crow and the gull. It knows the distance, too, at which it is safe from a man armed with a gun, and allows the shepherd and his dogs to come much nearer than the sportsman. It never ventures to attack a man plundering its nest, and rarely pretends to be crippled, in order to draw him away from it, but stands at a distance, looking extremely dejected, or flies over and around him, uttering now and then a stifled croak indicative of anger and anxiety. When searching for food on the ground, it generally walks with a steady and measured pace; but under excitement, it occasionally leaps, using its wings at the same time, as when driven from carrion by a dog, or when escaping from its fellows with a fragment of flesh or intestine. Its flight is commonly steady and rather slow, and is performed by regularly timed beats of its extended wings; but it can urge its speed to a great degree of rapidity, so as to overtake an eagle, or even a hawk, when passing near its nest. In fine weather it often soars to a vast height, in the manner of the birds just mentioned, and floats, as it were, at ease, high over the mountain tops. Some naturalists having observed birds thus engaged, have imagined them to be searching for food, and have consequently amused their readers with marvellous accounts of the distances at which the eagle can spy its prey; but had they patiently watched, they might have found that the quiet soarings of the raven and the rapacious species have no reference to prey. On the other hand, it may sometimes be observed gliding along, and every now and then shifting its course, in the heaviest gales, when scarcely another bird can be seen abroad. Although there is not much reason for calling it "the tempest-loving raven," it would be a severe storm indeed that would keep it at home, when a carcass was in view.

In the Hebrides, where this bird is much more abundant than in any other part of Britain, it may be seen either singly or in pairs, searching for food, along the rocky shores, on the sandfords, the sides of the hills, the inland moors, and the mountain tops. It flies at a moderate height, proceeding rather slowly, deviating to either side, sailing at intervals, and seldom uttering any sound. When it has discovered a dead sheep, it alights on a stone, a peat bank, or other eminence, folds up its wings, looks around, and croaks. It then advances nearer, eyes its prey with attention, leaps upon it, and, in a half-crouching attitude, examines it. Finding matters as it wished, it croaks aloud, picks out an eye, devours part of the tongue, if that organ be protruded; and, lastly, attacks the abdomen. By this time another raven has usually come up. They perforate the skin, drag out and swallow portions of the intestines, and continue to feast until satiated or disturbed. In autumn it sometimes commits great havoc among barley, and in spring occasionally destroys young lambs. It has also been accused of killing diseased sheep by picking out their eyes. It annoys the housewives by sometimes flying off with young poultry, and especially by breaking and sucking, or rather gobbling eggs, which the ducks or hens may have deposited, as they frequently do, among the herbage.

The voice of the raven is a hoarse croak, resembling the syllables *crock*, *cruck*, or *chrro;* but it also emits a note not unlike the sound of a sudden gulp, or the syllable *cluck*, which it seems

to utter when in a sportive mood; for, although ordinarily grave, the raven sometimes indulges in a frolic, performing somersets and various evolutions in the air, much in the manner of the rook.

The character of this bird accords well with the desolate aspect of the rugged glens of the Hebridian moors. He and the eagle are the fit inhabitants of those grim rocks; the red grouse, the plover, and its page, of those brown and scarred heaths; the ptarmigan of those craggy and tempest-beaten summits. This species is also very abundant in the Orkney and Shetland islands. In Sutherland, Ross-shire, and many parts of the county of Inverness, it is also not uncommon. In most of the Highland districts we have met with it here and there. In the lower parts of the middle division of Scotland it is of much rarer occurrence; nor is it plentiful even in the higher and more central portions of the southern division, although we have seen it in many places there. In England it is much less frequently met with than in Scotland, although it seems to be generally distributed there also. If we take the whole range of the island as its residence, we must add to its bill of fare many articles not mentioned above, so as to include young hares and rabbits; other small quadrupeds, as rats, moles, and mice, young poultry, and the young of other birds, as pheasants, grouse, ducks, and geese; eggs of all kinds, echini, mollusca, fruit, barley, wheat, and oats; insects, crustacea, grubs, worms, and probably many other articles, besides fish and carrion of all sorts. In the northern parts of Scotland the raven constructs its nest on high cliffs, especially those on the sea-shore; but in the southern parts of the island, where rocks are not so common as tall trees, it is said frequently to nestle in the latter. According to the locality, it begins to repair its nest, or collect materials for forming a new one, as early as from the beginning to the end of February. In the maritime districts, it is generally composed of twigs of heath, dry seaweeds, grass, wool, and feathers. It is of irregular construction, and very bulky. The eggs are from four to seven, pale-green, with small spots and blotches of greenish-brown and grey, and are about two inches in length. The young are at first of a blackish colour scantily covered with soft, loose, greyish-black down. They are generally abroad by the middle of May. It has been remarked, that when, during incubation, or even when the young have left the nest, one of the old birds is killed, the survivor soon finds a mate. Ravens, if unmolested, breed in the same spot year after year.

Few birds are possessed of more estimable qualities than the raven. His constitution is such as to enable him to brave the fury of the most violent tempests, and to subsist amidst the most intense cold; he is strong enough to repel any bird of his own size, and his spirit is such as to induce him to attack even the eagle; his affection towards his mate and young is great, although not superior to that manifested by many other birds; in sagacity he is not excelled by any other species; and his power of vision is at least equal to that of most others, not excepting the birds of prey, for he is generally the first to discover a carcass. To man, however, he seems to be more injurious than useful, as he is accused of killing weakly sheep, sometimes destroys lambs, and frequently carries off the young and eggs of domestic poultry. For this reason he is generally proscribed, and in many districts a price is set upon his head; but his instinct and reason suffice to keep his race from materially diminishing. He seems to have fewer feathered enemies than most other birds, for although he may often be seen pursuing gulls, hawks, and eagles, we have never seen any species attacking him with the exception of the domestic cock. It has been alleged, however, that rooks assail him in defence of their young, and there is nothing incredible in this, for the weakest bird will often in such a case attack the most powerful and rapacious.

The species is very widely distributed over the globe, being more or less common in Europe, Asia, and America, but more abundant towards the arctic regions.

RAY. See SCAB.

RAYGRASS. See RYEGRASS.

REAPING. The cutting down of ripe corn or pulse with a sickle, a scythe, or a reaping machine Most subjects connected with this operation are discussed in the articles SICKLE, SCYTHE, HAINAULT-SCYTHE, REAPING-MACHINE, BAGGING, MOWING, BANDS, SHEAVES, GAITING, RIDGE, HARVEST, FARM-SERVANTS, OAT, BARLEY, WHEAT, RYE, BEAN, PEA, and some others; so that the chief topics which fall to be noticed in the present article are ordinary reaping with the sickle, and the comparative merits of this practice and reaping with the scythe.

Reaping with the sickle, in so far as it is performed by specially hired reapers, is done by the season, or by the day, or by the acre, or by the bulk or amount of produce cut. In some districts or circumstances, each reaper cuts across the whole ridge, and makes bands and binds for himself; in others, a pair of reapers of unequal strength, often a man and a woman, have joint charge of a ridge, the stronger making bands for both himself and his fellow-labourer; in others, three or four or five reapers, of indiscriminate selection, or of nearly equal strength, have common charge of a ridge, each cutting along a narrow stripe of it, and all making bands and binding for themselves; in others, similar methods to the two preceding are practised, with the difference that one comparatively feeble worker, generally a female, makes bands and binds for every two reapers; and in others, one man and two women have joint charge of a ridge, the man cutting along the central portion and mak-

ing bands for both himself and the two women, and a binder or bandster following every two such sets of reapers and binding all the sheaves. The last of these is the method most common in the best districts of Scotland; and seems far the best for combining economy of strength or of labour with goodness of execution. Yet, says Martin Doyle, in decided preference of the next last, which is often practised in the cutting of wheat-crops in Ireland, "Two smart reapers with a fair crop will give a woman constant occupation in collecting and binding; and surely it is better at a critical season to employ the men in severing the corn alone, when active women can discharge the other part of the work equally well, and at a cheaper rate, too, and with the additional consideration that, by giving them such employment, the means of supporting their families are enlarged."

The art of reaping with the sickle, together with the risk of wounds on the part of beginners and the methods of dexterity on the part of the experienced, cannot be taught by book, yet may be promptly and easily taught by example, and need not therefore be described. But all reapers ought to have the habit of cutting the corn both evenly and low. Reapers who do not work in a sufficiently cowering posture, but keep their legs erect and bend the body only from the haunches, cut each sweep or breadth of the corn low in the front and high in the rear so as to give the surface of the stubble along a ridge the appearance of a series of notches; and the majority of reapers, whether they have this vice or not, and especially if they use the smooth and not the serrated sickle, are prone to cut so high from the ground as to leave a long stubble, and to cause a vast aggregate loss of straw. The desirableness of the shortest possible stubble, and the greatest possible quantity of straw, particularly in the vicinity of large towns where straw is sold at a high price, is the great motive for sometimes preferring the method of reaping called Bagging.

The comparative economy of reaping with the scythe, the smooth sickle, and the serrated sickle, has been much discussed, and is not well understood; and experiments for ascertaining it have not always, as they ought to have been, conducted under equally favourable circumstances, with implements of the most approved description, by scythemen and sicklemen equally dexterous in their respective art, and with sufficient scope and variety and frequency of repetition to detect and rectify contingent error. But a report on the subject, in the Highland Society's Transactions for July 1844, by Mr. John Taylor of Corsiestone, near Huntly, in Aberdeenshire, founded on "practical experience and minute observation," and prefaced with a full regard to the conditions of right experimenting, is so good that we cannot do better than give an abstract of it to our readers.

"In regard to binding," says Mr. Taylor, "the average number of sheaves, of an average crop of oats or barley, that one man can bind and stook in one day of ten hours, by these three modes, differs thus:—

Of sheaves reaped by the scythe, ...	1500
Of sheaves reaped by the smooth sickle, . . .	1200
Of sheaves reaped by the serrated sickle, . . .	1200

This difference is accounted for, first, by the mown sheaves being in regular rows of considerable length, the binder loses no time in moving from row to row, as in binding to shearers on two or three ridges; and, second, by mown stooks not requiring to be hooded. In practice, however, the binder binds less in a day to the scythe than to the sickle, because he binds to but one scythe, and the latter to six shearers, who reap more in a day than one scythe; but the binder to the scythe, if the crop be good, finds plenty of employment in assisting the gatherer in making bands. Sheaves reaped by the smooth and serrated sickles in the usual way are equally easily bound; but by the mode of reaping by the former, termed cuffing, the sheaves are not so neat, and the binder's work is more difficult, the sheaves requiring some dressing, and numerous fallen heads to be lifted up. Therefore, though a man may, and commonly does, bind as many sheaves in a given time, reaped by this, as by the usual mode, it must be by greater exertion, or else the work will be imperfectly done.

"In regard to winning, the prevalent opinion is, that grain reaped by the scythe is sooner ready for carrying than that reaped by either description of sickle, and my own experience is corroborative of this opinion. In regard to winning, the work of the smooth and serrated sickles, if done in the usual way, is quite the same. Sheaves reaped by the smooth sickle by cuffing (viz., striking with the sickle so as to cut and gather a sheaf together without grasping every cut with the left hand) have the advantage of being less compressed than if reaped in the usual way, but want the peculiarities of form which contribute to the winning of mown sheaves. In investigating the cause or causes of the difference of mowing and reaping, in regard to winning, the following peculiarities have particularly attracted my notice:—1, That, in a great majority of cases, and especially on narrow ridges, the straws composing a sheaf vary considerably in length. 2, That all the straws in sheaves, reaped by the sickle, reach to the bottom, or stubble end; and, therefore, including all the short straws within the sheaf, require the bands to be passed round near the bottom. 3, That binding in this way retards the process of winning in two ways—by compressing that part of the sheaf which most requires exposure, so as to render it almost impenetrable to the influence of sun and wind; and, by expanding its corn end so much, that when stooked, the stooks were almost as broad at top as at bottom; and, to defend these from rain, require hood-sheaves, which retard the winning of the grain. 4, That sheaves reaped by the scythe are even, or nearly so, at the top or corn end, and, to include all the short straws, require the bands passed round a little below the ears of corn. 5, That binding near the top expands the bottom, and gives the sheaf a tapering form from bottom to top; for though the straws are more numerous at top than at bottom, they are much smaller, more compressed, and consequently occupy less space. 6, That, when set up, the ridge of the stook is very acute, leaving the least possible admission for rain, and therefore requires no hoodsheaves. And 7, That, after heavy rain, stooks reaped by the scythe are sooner dry than those reaped by the sickle, because the wet naturally sinks toward the bottom of the sheaf, but the former, being open, allows it quickly to escape by evapora-

tion, while the latter, keeping it tight within the band, dries slowly.

"In regard to carrying and stalking, as has already been remarked, mown sheaves are closer and firmer at top than shorn ones, and, on this account, lose less grain by shedding than the latter, in the processes of carting and stacking. By observation, I am quite satisfied that this is the case, but cannot say precisely to what extent, nor could it be easily ascertained. Sheaves cut by the sickle are even at the stubble end, and, therefore, a stack wall is easier built of them than of mown sheaves, and has a more handsome appearance; but, being close, excludes the air from the interior. A stack wall of mown sheaves is rough but open, and can be put up with safety in a state of dampness, which would be destructive to shorn sheaves. When a crop is reaped with the scythe by inexperienced hands, a considerable quantity of grain is exposed on the outside of the stacks, owing to the straws having been irregularly laid into the sheaves; but with dexterous mowers, the quantity thus exposed will be very trifling, as it only happens when the wind blows in a direction contrary to that in which the crop has been laid by a previous storm, and not sufficiently strong to turn it completely back, that the mower finds it impossible to make an even swathe. A case of this kind rarely occurs, and when it does, the grain exposed in consequence need not be lost. A man with a scythe-blade fixed to a fork-shaft can dress a stack in an hour, spreading a sheet of canvass at the bottom to receive the heads of grain as they are cut off. With respect to carrying and stacking the work of the smooth and serrated sickles, provided they have been alike carefully performed, they are very little dissimilar.

"In regard to thrashing of mown and shorn grain, the flailman gives preference to the latter, because the grain is more exposed to the action of his implement, and is, therefore, more easily beaten out. In ordinary cases, a flailman can thrash about 10 per cent. more of shorn than of mown sheaves; and if the mowing has been improperly performed, the difference will be still greater. A good machine will thrash the one kind as effectually and expeditiously as the other; but mown sheaves are more difficult to part asunder than shorn, and although a man may feed both kinds equally fast into the machine, the former fatigue him more, as they require greater force to separate them. As to thrashing the work of the smooth and serrated sickles, it is much the same; however, by the smooth sickle, some straws are apt to be laid in a wrong direction, and usually some rakings are left, and a feeble or imperfect machine will not thrash the rakings and inverted straws perfectly—and, to thrash these well, they must be put twice through the machine. By the serrated sickle, fewer straws are in a wrong position, and there are no rakings to be dealt with.

"As to the amount of work performed by different modes of reaping,—having had many opportunities of ascertaining this point in various parts of Scotland, I shall here state what I have found to be the average amount of work performed by a band of reapers with scythes, and smooth and serrated sickles—the reapers being in every case thoroughly trained to their respective modes of reaping. Seven is the most convenient number, as six reapers require one binder, and two mowers require five attendants, viz., two gatherers, two binders, and one raker. Seven reapers, then, will reap of an average crop in one day of ten hours:—

	Of Wheat.			Of Oats or Barley.		
	Acres.	Roods.	Poles.	Acres.	Roods.	Poles.
By the scythe, . .	2	3	0	4	0	20
By the smooth sickle,	1	1	18	2	2	10
By the serrated sickle,	1	0	8	2	0	10

This shows a considerable difference in favour of the scythe, although I have stated the average extent of land reaped by expert shearers when working briskly. In this district, it is thought no great feat for one man to mow three acres of a light crop in one day; in fact, I have repeatedly done so myself, but with very great exertion; but of a fair crop two acres, or very little more, is as much as can be done; the mower might do more, but this is as much as two attendants can gather, bind, and stook, and a third cannot be employed to advantage.

"As to the comparative merits of the different modes of reaping, the preceding facts show a difference in favour of reaping by the scythe, with the exception of thrashing, which is comparatively an unimportant point, as the quantity of grain thrashed by the flail in Scotland is very trifling. There is another and somewhat serious objection urged by the opponents of mowing, namely, that more is left by it for the rake than by shearing, and that that so left is either lost altogether or deteriorates the rest of the crop if mixed amongst it. This, I admit, is, in many instances, true enough; but is it an unavoidable result of reaping by the scythe? Assuredly not. I beg to submit that I have employed mowers for ten harvests, and that the quantity left to the rake has not averaged more than 4½ per cent., which is little more than what is commonly left by the smooth sickle, and I have neither left the rakings to rot in the fields, nor spoiled the rest of the crop by them; and I know no good reason why others should do so. When a crop is reaped by the serrated sickle, there is nothing left to the rake, but this is its only recommendation; it is otherwise a laborious and expensive mode of reaping, and has now, with few exceptions, given place to the smooth sickle and the scythe. As it is now little in use, few can reap with it without uprooting part of the straw. With respect to learning to reap with the scythe and either kind of sickle there is this difference,—beginners with the sickle very soon learn to reap neat enough, but are defective in point of speed,—beginners with the scythe very soon learn to reap fast enough, but are defective in point of neatness. Both mowers and gatherers require some instruction, besides a few days' practice, before they can do their work properly; even although the former be good mowers of hay, they will require some practice in mowing grain, to enable them to lay it evenly in the swathe; but, if they are anxious to learn, a very short time will suffice;—and until mowers and gatherers are both expert, their conjoint work will appear rough and defective."

REAPING-HOOK. See Sickle.

REAPING-MACHINE. A machine for cutting down corn-crops and other field crops by means of horse labour. It is desirable for the sake of saving expense of reaping, of creating independence of temporary and precarious supplies of labourers, of expeditious harvesting in a fickle or critical season, of preventing over-ripeness in any part of suddenly and contemporaneously maturing crops, of commanding a competent harvesting apparatus for increasing breadths of corn cultivation in farms and districts, and of enabling farmers to thrash out a part of their crop immediately on its being carried from the field. Mr. Slight calculates, from the instance of the most recent good attempt at constructing an effective reaping-machine, that the expense of it, in the saving effected over the average cost of hand-reaping, would probably be saved

in one year; and he adds, "But suppose the price of a machine could be saved even in two years, the advantages would be very great, under the supposition that an effective machine could be procured for £30. It is deserving of consideration, also, that although no reaping-machine is to be expected capable of cutting down the crops in every possible state, yet we may infer that, even on a farm of ordinary extent, such a breadth of crop may be found, in almost any season, capable of being cut by a machine, as would save half the expense of the purchase. To obtain an effective and durable reaping-machine is, therefore, yet an important object to the farming interest."

This object, however, seems slow to be realized. Rude attempts toward it were made so long ago as the time of the ancient Romans; many and most ingenious attempts toward it have been made, both in Britain and on Continental Europe, in the course of the present century; several of the modern attempts have excited sanguine hopes, and have even seemed for a time to be entirely triumphant; and yet, for all purposes of general utility, a tolerably fair attempt, to say nothing of a really successful one, has yet to be made. The very best of the many reaping-machines hitherto constructed, though very beautiful and highly ingenious pieces of machinery, are but a degree better than mere curiosities, and do not require therefore to be lengthily described. Three of them, indeed—Smith's, Bell's, and Mann's—do pretty well on crops which everywhere stand quite erect, or which, if inclined at all, are inclined but slightly and everywhere in one direction; but all fail, or make most unsatisfactory work, on crops which are contorted by winds or lodged by rains.

Boyce's reaping-machine was patented early in the present century, and was the first reaping-machine of considerable promise. It was mounted on a two-wheel carriage, somewhat similar to a common cart, but with fixed wheels or revolving axle; it had a vertical spindle which descended to the proper cutting distances from the surface of the ground, and was there armed with a number of horizontally adjusted scythes; it communicated motion to the spindle by mechanical connexion with the revolving axle of the carriage; and it hence cut down the growing corn by a rapid revolution of its scythes,—a revolution produced by the carriage being wheeled along; but it had no provision for gathering the corn into parcels or for depositing it in heaps or in any proper order.

Plucknet's reaping-machine, made by an agricultural implement maker of that name in London, was similar in general structure to Boyce's, but, instead of the scythes, had a notched, sharp-edged, circular steel-plate, which cut the crop with a similar action to that of a very fine toothed saw.

Gladstone's reaping-machine, made by Gladstone of Castle-Douglas in Kirkcudbrightshire, was even nearer in principle to Plucknet's than Plucknet's was to Boyce's; but it consisted of superior workmanship, and comprised contrivances for keeping the cutting edge in constant sharpness, and for gathering the cut corn and depositing it in parcels.

Salmon's reaping-machine was made by Salmon of Woburn, and was a still later invention than Gladstone's, and was constructed on a widely different principle, and gave still higher promise of success. It cut the corn by means of shears, and had an ample and effective apparatus for depositing it in parcels.

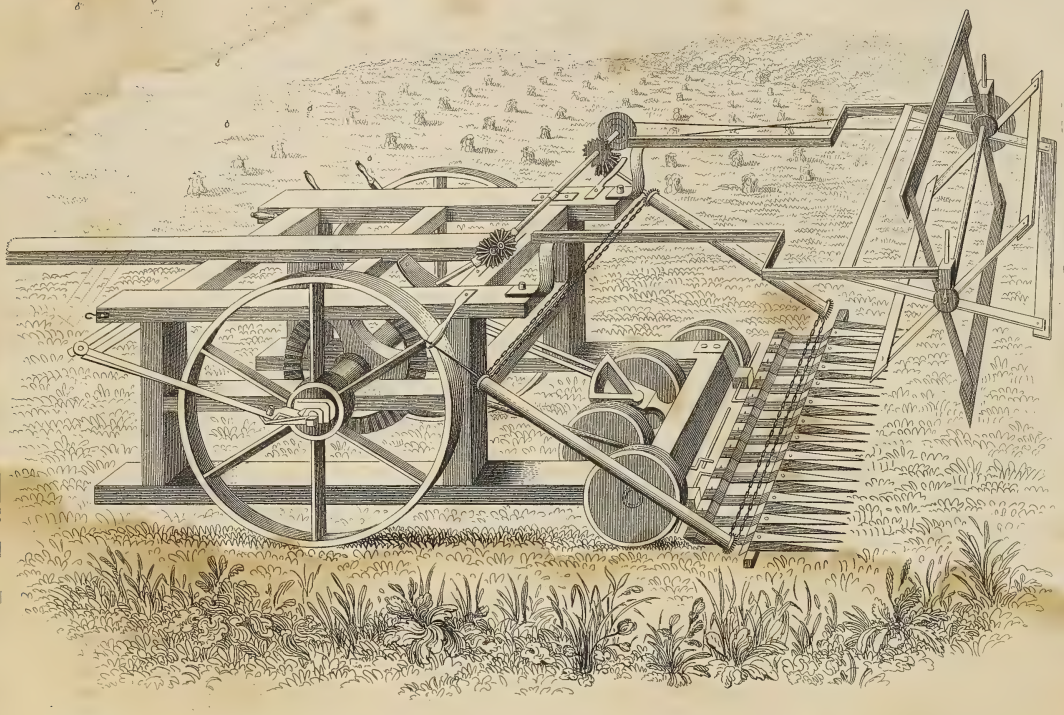
Ogle's reaping-machine was invented in 1822 by Mr. Henry Ogle, schoolmaster at Rennington, near Alnwick, in Northumberland, and was undertaken to be furnished by Messrs. Brown, iron-founders in Alnwick, and comprised apparatus for sheaving corn as well as for cutting it, and was estimated to cut 14 acres per day, and is said to have done its work on trial in a satisfactory way, yet does not seem to have ever won the confidence of any practical farmer. A figure and a description of it may be seen in the 5th volume of the Mechanic's Magazine.

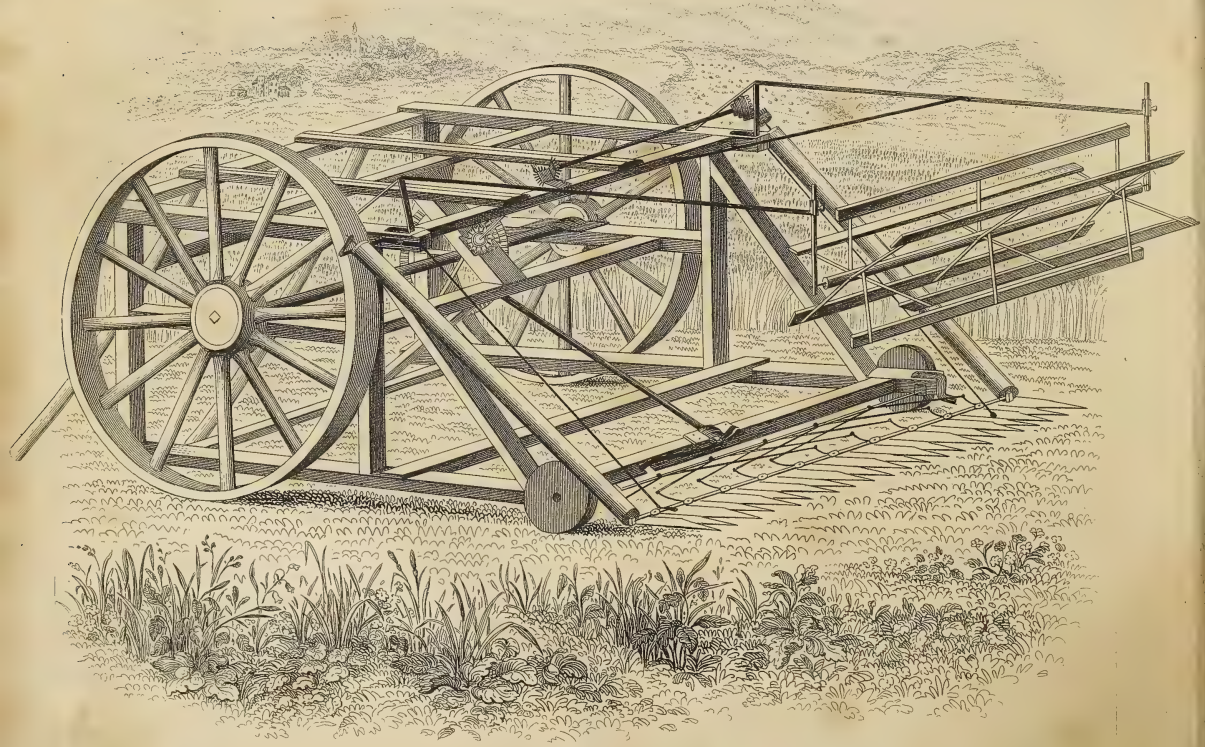
Smith's reaping-machine, the invention of Mr. Smith of Deanston, was tried so early as 1811, and came prominently into notice in 1816, and underwent a series of important improvements from the period of its first trial till about the year 1837. It from time to time excited great hopes; and seemed at each successive improvement to have almost reached the point of complete success; yet, it is probably farther at the present day, than ever it was, from coming into ordinary practical use. Its cutter is a continuous circular knife, revolving with considerable velocity; and its gathering apparatus comprises a revolving rake, placed over and concentric with the cutter, and lays the cut corn down at one side of the track of the machine. It is pushed by two horses, and cuts a breadth of about 4 feet; but it has a length of about 20 feet, and is exceedingly unwieldy.

Bell's reaping-machine, invented by the Rev. Patrick Bell of Carmylie in Forfarshire, was put into operation in 1827, and received a premium of £50 from the Highland and Agricultural Society of Scotland; and during several years, it was much talked of among the best-informed circles of agriculturists, and seemed to bid fair to render itself worthy of practical adoption; yet, almost or quite as much as Smith's, it has caused eventual disappointment, and is passing into oblivion. It cuts on the clipping principle, by means of a series of shears; and it combines with this a gathering apparatus which lays the cut corn on an endless web, and, by means of this, deposits it along one side of the machine's tract. It is pushed by two horses, and cuts a breadth of 5 feet. A figure and description of it may be seen in the first volume of the Quarterly Journal of Agriculture.

BELL'S REAPING MACHINE.

(In Different Stages of Improvement.)





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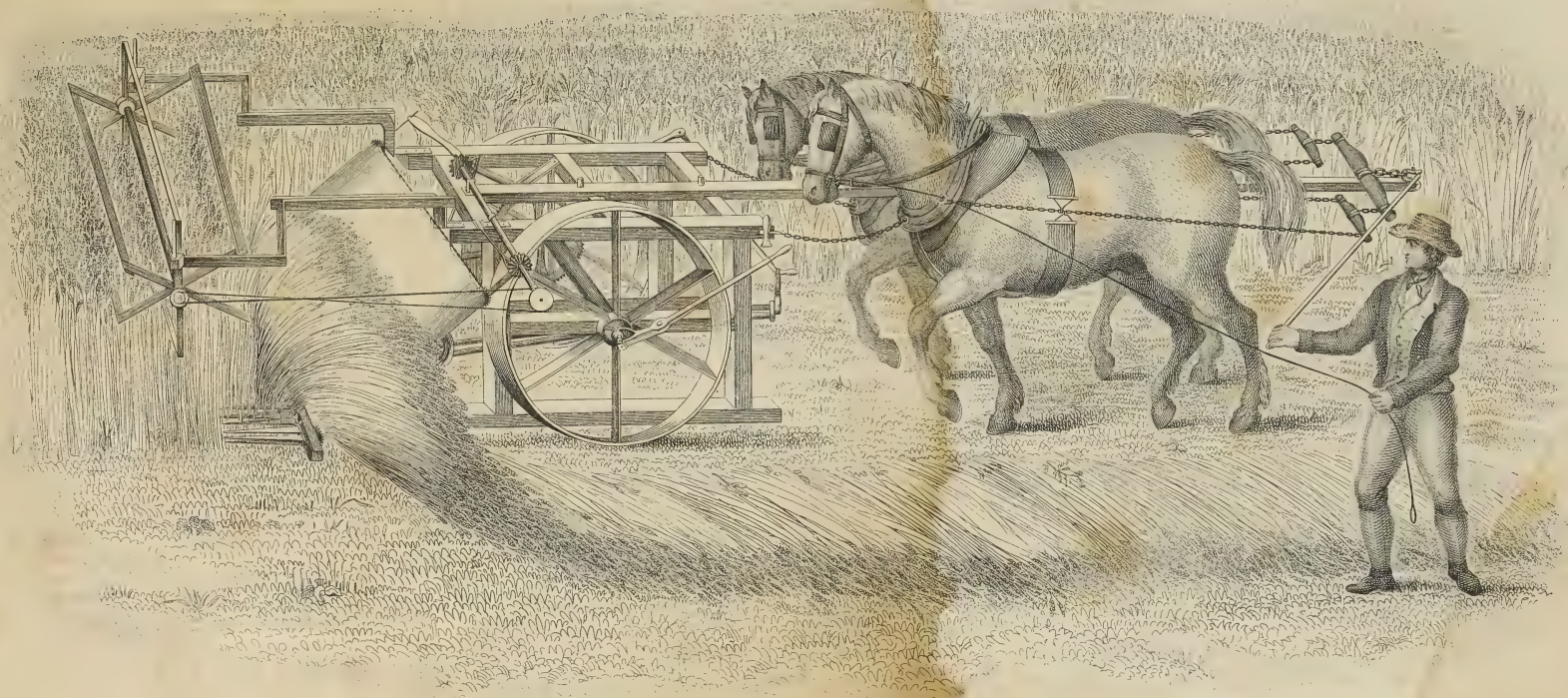

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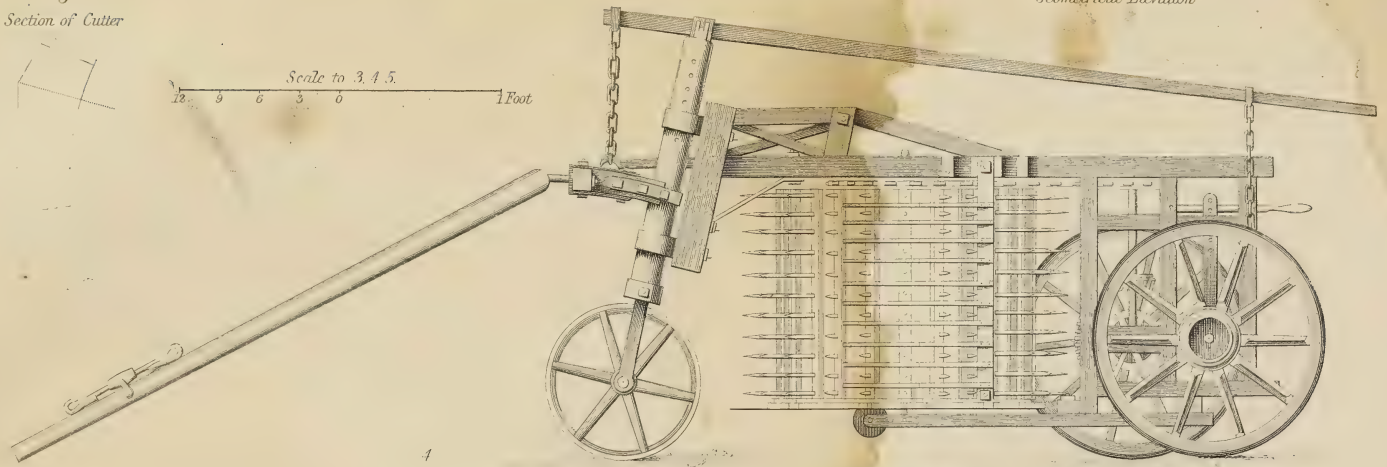


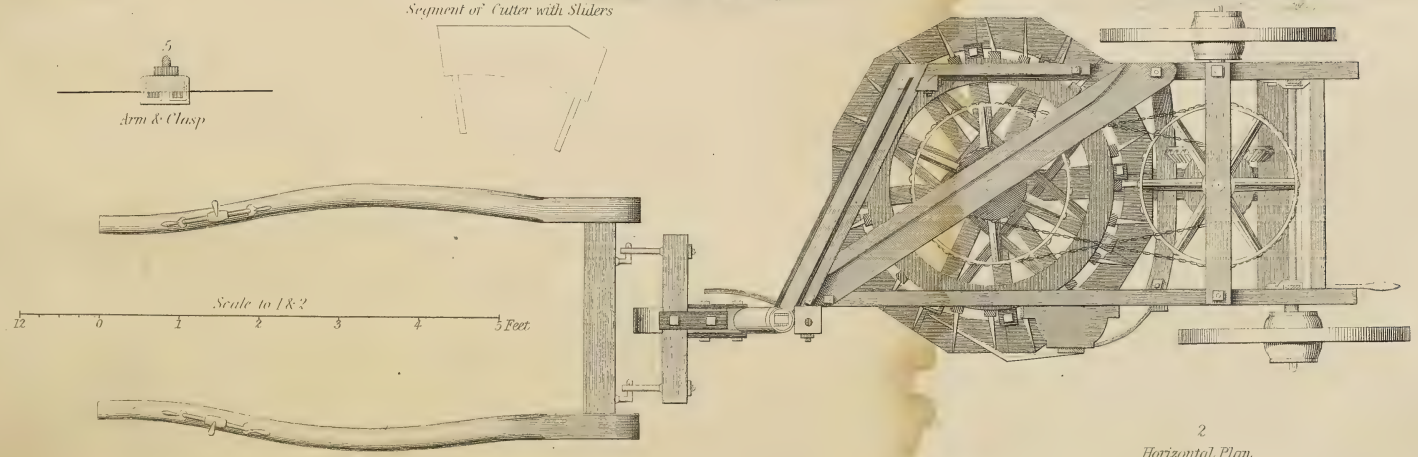
1
Geometrical Elevation

3
Section of Cutter

Scale to 3, 4 5.
12 9 6 3 0 1 Foot

4
Segment of Cutter with Sliders

5
Arm & Clasp



Scale to 1 & 2
12 0 1 2 3 4 5 Feet

2
Horizontal Plan

Mann's reaping-machine, invented by Mr. Joseph Mann of Raby, near Wigton, in Cumberland, was first of all tried in 1822, and first tried in an improved form in 1826, and first tried in Scotland at the Kelso meeting of the Highland Society in 1832. It made similar promise to Smith's and Bell's; and had it been as perseveringly improved as the former, it might possibly have won the confidence of practical men; but—quite as much perhaps from want of hope on the part of its proprietor, as from want of encouragement on the part of leading and influential agriculturists—it is going to rust along with its predecessors. It has a revolving polygonal cutter of 12 equal sides, and produces its cutting effect by a very rapid series of strokes; it gathers the cut corn by means of revolving rakes, and strips these in such a manner as to lay down the corn in a regular swathe; it is drawn by one horse walking along the side of the standing corn; and it cuts a breadth of 3½ feet at each turn, and is capable of cutting about 10 acres in 10 hours. A figure and a description of it may be seen in the 6th volume of the Quarterly Journal of Agriculture.

REARING. A horse's tossing aloft his two fore legs, so as momentarily to poise his whole body on his two hinder feet. This proceeds sometimes from playfulness, sometimes from sharp reining, and sometimes from sheer vice; and in the first and second cases, it may be cured by using a snaffle-bridle,—but, in the third, is both incurable and very dangerous. A viciously rearing horse, indeed, is sometimes dealt with by being pulled over backward by a rider upon a soft piece of ground; but this risks both the spine of the horse and the neck of the rider,—and implies an appalling degree of both brutality and recklessness.

REDBREAST,—*Motacilla rubecula.* A bird familiarly known to every child, from the numerous stories in which it plays a prominent part. The fame of this bird has arisen from its habit of seeking the aid of man during the winter season. During that inclement period of the year, it visits without dread the cottage of the peasant and the palace of the peer, tapping at the windows with its bill, as if to demand an asylum, and repays its host by its confidence, gathering the crumbs from the table, and warbling forth its thanks in the softest notes. The moment, however, the spring appears, this familiarity with its protectors ceases, and it again hastens to its native haunts. The redbreast builds its nest at the foot of some shrub or upon a tuft of grass; it is composed of dried leaves, mixed with hair and moss, and lined with feathers; the female lays from five to seven eggs. Sometimes it covers its nest with leaves, leaving a small passage for egress and regress. The food of the redbreast varies with the season; in the spring it is composed of worms and insects, but in autumn is principally fruits and seeds. Its delicacy in preparing a worm before partaking of it, is somewhat remarkable; it first seizes it by one end in its beak, and beats it on the ground till the inner part comes away; then, taking it in the same manner by the other end, it cleanses the outer part, which is the only portion it eats. From its general familiarity with mankind, it has received a *nom de caresse* in almost every nation in Europe; in England it is known as the *Robin Redbreast;* in Germany it is termed *Thomas Gierdet;* and in Norway, *Peter Ronsmad.*

REDBUD. See Judas Tree.

RED CEDAR. See Juniper.

RED CLOVER. See Clover.

RED-CRAIG. See Marl.

RED GUM. See Rust and Mildew.

RED LAND. See Soil.

RED LEAD. The sesqui-oxide of lead, or a mixture of the protoxide and deutoxide. It is well known in commerce, as a pigment, and in the manufacture of flint-glass. See the article Lead.

RED PINE. See Pine.

REDPOLE. Two British song-birds, of the linnet genus and finch family of passerinæ.—The smaller or common redpole, *Linota linaria,* is the smallest of the British linnets; and has a total length of 4¼ inches. The upper part of the body is brown, spotted with black; the wing is traversed by two white bands; its throat is black; the breast and the top of the head of the adult male are red; and the rump also is sometimes red. This bird resides throughout the year in Scotland and the north of England; and appears in small flocks from Michaelmas till April in the south of England. It feeds on the buds of trees, and on willow, birch, and alder catkins; and, when it lives in flocks, it sometimes inflicts severe injury on plantations. Its nest is built in a bush or low tree, and consists of moss and dried grass and willow catkin down. Its eggs amount to 4 or 5, and have a pale bluish green colour, spotted with orange brown.—The larger or mealy or stone redpole, *Linota canescens,* is regarded by some naturalists as only a larger variety of the common species. It is about 5¼ inches long; and it differs from the common redpole, both in the size of the bill and in some tints of the plumage.

RED-RAG. See Rust and Mildew.

RED RATTLE. See Rattle.

RED ROBIN. See Rust and Mildew.

RED SANDSTONE. See Geology.

RED SAUNDERS WOOD. See Pterocarpus.

REDSHANK,—scientifically *Totanus.* A genus of birds, of the grallæ order. Their form is light; their legs are long; only a small part of their thumb rests on the ground; their external web is well-marked; their bill is slender, solid, round, and pointed; their nasal fossæ do not extend through more than one half of their bill; and their upper mandible is slightly arcuated near the end. The several species occur through-

out the greater part of the world; and two of them frequent the shores of Britain.

The common redshank, *Totanus calidris*, inhabits many parts of Britain throughout the year, but frequents the coast in flocks during winter, and the fens and marshes adjacent to lakes and streams singly or in pairs during spring. It feeds on aquatic insects and worms, and probes for them in mud and silt. Its extreme length is about 11 inches; but is greater in the female than in the male. In winter, the upper part of its body is ashy brown, and the breast, the belly, the front of the neck, and the stump and tail feathers are white, with a few slight dusky streaks in the line of the shaft of the feathers; and in spring, the under part of the body, the sides, the flanks, and the front of the neck are streaked and spotted with brownish black. It builds its nest with coarse grass in the fens, and begins to lay early in May; and its eggs have a pale reddish white colour, tinged with green, and blotched with dark red brown.

The spotted redshank, *Totanus fuscus*, is a great deal rarer than the common species, yet is sent not unplentifully to the London market in autumn and winter. Its total length is about 12½ inches. Its bill is straight and moderately long; its plumage is ashy on the back, grey on the breast, and pure white on the belly at one season, but changes to a sooty black at another; and its legs and toes have a vermillion red colour, and its wings white spots, throughout the year.

RED SPIDER,—scientifically *Acarus Telarius*. A plant-infesting mite,—a minute microscopic animal, of the holetra family of spiders. It belongs to a prodigiously multitudinous genus, which infest a large proportion of the organic tribes of our world, in both their living and their dead states, and many of which are parasites, and have an intimate connexion with some of the most loathsome cutaneous diseases of mammals. All the acari or mites are oviparous and amazingly prolific.

The red spider or common plant mite is a great and general destroyer among the tender and half-tender exotics of the garden, and vies with the aphides in giving work and vexation to gardeners, and, not only has a prodigious fecundity, but multiplies almost equally at all seasons of the year. The eggs are generally deposited on the back of leaves, where they are best sheltered from strong light; and they are very minute, and of a whitish colour, and not collected in masses, but scattered loosely and dispersedly all over the surface. The young ones, soon after being hatched, begin to move about upon the leaves. They are at first colourless, and remarkably small, but of the same form as the parents; and as they advance in growth, they become more and more red; and when they are half-grown, they become very active; and when they attain maturity, they are dark brown and slightly hairy. During the progress of their growth, they several times cast their skins; but they do not undergo any other apparent change except increase of size and darkening of colour. They weave for themselves close silken webs; and they travel by means of these from one leaf to another; and the young are also sheltered by them from the sickening or killing effects of ordinary moisture. Both the middle-aged and the full-grown animals are so very minute, that, except when viewed through a microscope, they appear on the leaves like mere red moving dots.

Many means have been proposed of destroying the red spider or of preventing its appearance. One of the simplest and most efficacious, at any season of the year or in any condition of the plant-house in which it can be applied without injury to the plants, is excessive humidity; and a kindred one, which can often be applied at other seasons and other conditions, is daily syringing with clear water. Another is to bruise laurel leaves beneath the infested plants, so as to kill the spider with their liberated, aeriform, essential oil; but this amounts to the diffusion of prussic acid through the local atmosphere, and is dangerous to man. Most of the other remedies derive their efficacy from sulphur, applied in many forms and in many combinations, either aeriformly or liquidly or as a wash upon flues or walls; and one of the oldest-fashioned or most extensively employed of these may be selected as a good enough coarse specimen of all the rest:—"Take half a pound of flower of sulphur; put it into a watering pot, and add as much water as will make it into a paste; afterwards add more, until sufficiently thin; pour it into a garden engine or other vessel capable of holding 4 or 5 gallons; then add as much water as will make it into 4 gallons; and water the infested plants with this overhead, and repeat the application till every insect disappears."

Two facts respecting the red spider are remarkable,—that it is thought by some intelligent observers to be rather useful than injurious to plants, and that another and certainly harmless species of acarus is often mistaken for it. The way in which it is supposed to be useful is by its destroying the *Coccus hesperidum* or brown scale, and sometimes also different species of aphides; and the acarus which is mistaken for it is *A. holosericeus*, or the scarlet spider, which is much larger than the red spider, and lives solitarily, and does not form any web, or fix on any particular plant or leaf for its residence.

REDSTART. Two British song-birds, of the warbler family of passerinæ.

The common redstart, *Phœnicurus niticulla*, *Sylvia phœnicurus*, or *Motacilla phœnicurus*, arrives in the southern counties of England about the second week of April, and proceeds thence toward the west and the north. It is rare in some places, and not very plentiful in any. Its total length is 5¼ inches. The head, back, and

wing-coverts of the male are leaden grey; the forehead is white; the chin, the throat, and the side of the face and neck are jet black; the breast and the belly are pale chestnut; and the legs and the toes are brown. This bird inhabits gardens, orchards, parks, meadows, and the skirts of forests; and builds on ruins, old walls, decayed trees, and many very curious situations; and feeds on worms, beetles, flies, ants, larvæ, spiders, and various kinds of garden and orchard fruit. Its song is soft, and has something of the modulations of the nightingale. Its nest is loosely built, and consists externally of moss, and internally of hair and feathers. Its eggs amount to from four to eight, and have an uniform greenish blue colour.

The black redstart is variously called, as to genus, *Phœnicurus*, *Sylvia*, and *Motacilla*, and, as to species, *tithys*, *tytys*, *erithacus*, *atrata*, and *gibraltariensis*. It is much more uncommon than the common redstart, and may be readily distinguished from it by the sooty colour of its breast and belly. Its total length is $5\frac{3}{4}$ inches. The bill of the male is black; the irides are blackish brown; the back, the neck, and the top of the head are dark bluish grey; the wing-coverts are greyish black; the rump and the tail-coverts are chestnut; the cheeks, the throat, the breast, and the sides are sooty grey; the belly is slaty grey; and the legs and toes and claws are black. This bird has similar habits to the common redstart, but delights in stony places, and is seldom seen in low and level districts. It feeds on worms, larvæ, insects, garden berries, and the smaller garden and orchard fruits; and builds in walls, roofs, clefts of rocks and similar situations. The nest consists principally of grass, with a lining of hair; and the eggs amount to 5 or 6, and are white, smooth, and shining.

RED WATER. A common, severe, and untractable disease in cattle and sheep.

Red water in cattle is also called hæmaturia, moor-ill, darn, bloody urine, foul water, and, in its last stage, black water. It has been the subject of much discussion, both in Britain and on the Continent, both among practical observers and scientific men; and it continues, in a considerable degree, to be the topic of diversified and conflicting opinion as to at once its causes, its nature, and its proper treatment. Seven select essays on it may be seen in the 9th volume of the Highland Society's Transactions; and discussions of it, more or less valuable, occur in the Veterinarian and in all the best treatises on veterinary medicine.

Red water is sometimes acute and sometimes chronic, sometimes isolated and sometimes epizootic, sometimes apparently connected with particular kinds or states of pasture and sometimes apparently unconnected with any particular kind of pasture, generally irrespective of any distinctions of breed or sex or age or condition of cattle, and occasionally peculiar to cows immediately after parturition; and it may, therefore, be in some sense regarded, not as strictly one disease, but as a group of mutually related or mutually similar diseases.

When it attacks newly calved cows, it probably arises from change of food about the period of parturition, or from want of sufficient cleansing, or from previous fulness of the blood, or from all these causes or any two of them combined; when it attacks cattle on particular pastures, and does not attack cattle on immediately adjacent ones, it probably arises, wholly or partly, from the eating of acrid plants, such as *Ranunculus acris*, *Ranunculus flammula*, *Anemone nemorosa*, and *Anemone ranunculoides;* but when it makes its attacks in other circumstances, or does not appear to have any traceable connexion with peculiar states of herbage, it probably arises from such a complication of causes as cannot be easily or very certainly explored. Mr. Robert Thomson, the first of the Highland Society's essayists, says, "It is most prevalent in old foggy pastures. It is seldom seen in hill pastures, or in new sown pastures, in which there is abundance of clover; but it sometimes happens at the stall, where the animal has no other allowance than straw, turnips, and potatoes. It usually makes its appearance after a few days of rain, followed by cold dry weather." Mr. William Laing, another of the essayists, says, "I am led to infer that close confinement in winter is one predominating cause, the cattle being thus deprived of the necessary exercise, fresh air, and access to earth, which seems to be useful in correcting the acidity produced in the stomach by costiveness and obstructed bile. Frosty water is also another cause, as it tends to produce indigestion, bad chyle, and consequently bad blood. Barley chaff, given in its natural state, but more particularly when boiled, may also occasion it, by destroying the sensibility of the villous coats of the stomach. It occurs most frequently in the end of autumn, in winter, and more particularly in the early part of spring." Mr. A. Watt, a third of the essayists, says, "It is produced by dry food, difficult of digestion, and is always found among cattle that are fed off newly improved lands, and on turnips and straw that have grown on poor ground. Neglect of proper watering, and feeding on turnips after they have begun to grow in spring, are also causes." And Mr. Andrew Henderson, a fourth of the essayists, states, as the result of extensive observation during 20 years, that "upon a light soil, liable to be soon burnt up for want of moisture, he found ten attacks of the disease for one upon any of the neighbouring farms which might happen to have a deeper soil," — that "the prevalence of the disease in such a situation was solely regulated by the state of the season, for in a moist season not a single instance perhaps would occur, while in a dry one numerous cases would appear,"— that, while passing by stock who were stationary

it occasionally attacked cattle who experienced a change of pasture, particularly when the change was from fine to coarse herbage,—and that, in the course of most journeys of droves of cattle from Scotland to the markets of the south of England, many violent attacks occurred; and in reference to the last of these facts, he says, "I have observed, that 20 females for one male were attacked, and more especially such as had had calves,—that at the commencement of the journey, the disease was not prevalent, provided there was a constant supply of water, and the weather proved steady,—that during a long-continued drought, the cattle were very subject to the disease, especially when pure water could not be had,—that sudden changes of weather were also apt to induce the disease,—and that at the commencement of the journey, some of the cattle were generally affected, although no perceptible change had taken place in the quality of the food, and although the cattle had not been exposed to any of the above causes. This must have proceeded from inflammation induced by sprains, bruises, or over-heating, caused by the cattle fretting and riding upon each other, as well as by the unmerciful strokes of the drivers." These details of observed causes in the course respectively of calving, of depasturing, of farm-yard feeding, and of journeying, ought to suggest to all proprietors of cattle-stock the several and most effective means of prevention.

"The first symptom of red water," says Mr. Thomson, "is the appearance of something like blood mixed with the urine. So trifling is the complaint in some instances, that no inconvenience seems to be felt by the animal, which eats and drinks as usual, chews the cud, and is free of the disease in a few days. In such cases, a natural diarrhœa comes on, to which the cure may be attributed. In general, however, the disease is not observed until the animal refuses food, separates from the rest of the herd, appears dull and heavy, and manifests great languor and apathy. The ears droop, the urine is of a reddish or brownish colour, and if it be a milch cow, the milk is often similarly tinged. The pulse ranges from 60 to 70; there is obstinate constipation of the bowels; the urine is discharged in moderate quantity, and apparently without pain. If relief is not afforded by some brisk purgative, at the period when the urine changes colour from red to brown, the pulse begins to sink; and if a little blood be drawn at this time, its surface assumes a brownish colour; the eye appears of a yellowish brown tint; the urine acquires a darker hue; the animal refuses to rise; the pulse sinks; the legs, tail, and horns, turn cold; and the animal dies, to all appearance perfectly exhausted, although it has manifested no symptoms of acute pain during the course of the disease. On removing the skin in animals which have died of this disease, the subjacent parts have a peculiar dark yellow appearance. The abdominal fat has the same colour. The first and second stomach are generally pretty full of food. The third stomach, or manyplies, is dry; its rugæ are inflamed; its contents compressed as by general spasm. The fourth, or true stomach, is nearly empty; its gastric juice tinged of a dark yellow colour. The small intestines show no marks of inflammation, but their mucous coat is tinged of the same colour. The rectum contains indurated fæces covered by brownish slime. The liver is of a darker colour than natural, but does not appear to be diseased in structure. The gall-bladder, in all cases that I have seen, is full of black, thick bile, somewhat resembling lamp-black and oil. The ductus communis choledochus does not appear to be obstructed, or if it is, this is effected by the presence of the neighbouring viscera. The fat surrounding the kidneys is healthy, but of a dark yellow tint. The kidney shows no appearance of disease, and, on being compressed, emits a few drops of urine similar to that in the bladder. The latter organ is healthy, but full of dark-coloured urine, resembling the thinner parts of the contents of the gall-bladder. There is no accumulation of fluid in the cavity of the peritonæum. The thoracic viscera are healthy, but tinged with yellow, as are the liquor pericardii, and the cerebral fluid. The contents of the lacteals and thoracic duct are of a dark brown colour. From the above appearances, the third stomach might seem diseased, but if water or liquid drinks be given plentifully before death, this appearance of dryness of the contents and inflammation will not take place. We must, therefore, seek the cause elsewhere. The kidneys are healthy, but the urine is tinged brown. The whole secretions are also more or less tinged. Shall we suppose, then, that the whole apparatus of secretion is diseased, or that the absorption of black inspissated bile into the blood colours all the secretions, as jaundice does in the human subject? This seems the most reasonable supposition. Bile regurgitated into the substance of the liver, can be taken up by the absorbents and passed into the blood, causing derangement of the functions of secretion, and giving a red appearance to the urine, milk, &c. If constipation of the bowels be present, the bile may be taken up by the absorbents of the mesentery, and introduced into the circulation; and, if continued for some time, the whole blood will become poisoned as it were, and unfit for the support of animal life, although there is no appearance of mortification in any part of the system, but all the secretions, together with the fat, are more or less tinged with a dark brown or yellow colour."

The empirical treatment of red water, on the part of stock-farmers, cow-doctors, and veterinary quacks, exhibits the most astonishing variety, and comprises almost a museum of absurdity, and might be instructively detailed, through scores of grotesque and monstrous particulars.

in illustration of human ignorance and folly. Even the professional treatment of it on the Continent has a strong dash of the vague and the ridiculous. But the treatment recommended by all the best British veterinarians is intelligible and simple, and consists mainly in purgation, accompanied with the administration of subordinate remedies suited to the secondary or adventitious symptoms. Mr. Thomson's prescription is one of the clearest, and is declared by Youatt to "comprise the substance of that treatment which is founded on principle, and will be attended by success where success can be attained," and is stated in the following terms:—"Purgatives of any kind, if given in large quantities of water, are found to be the best medicines that can be employed. Medicines given to cattle that have lost the power of chewing the cud, generally pass into the first and second stomachs, and if a good draught of water is not given to wash them from thence, if the animal dies the greater part of the medicines will be found in these stomachs; and upon this principle, common salt, if properly managed, will be found among the best. Dissolve the quantity to be given in as much water as will enable it to pass freely from the bottle or drenching horn, and let the animal have plenty of water to drink afterwards. Should it refuse to drink, no time should be lost in drenching it profusely with water. Without a plentiful dilution, there is no certainty of purging cattle that have lost their cud. If purging does not commence in from 12 to 24 hours, a second dose should be given. Injections of soap and water should also be tried if the case is obstinate, and when they operate, a pint of linseed oil should be given as a laxative. So obstinate is the constipation in some cases, that the salt acts only as a diuretic, causing a plentiful discharge of urine. Diuretics and astringents combined seem only of service when the bowels are open, and their improper administration often causes inflammation of the bowels and kidneys. If, after purgation, the bowels are kept open by laxatives, such as linseed infusion, the disease will gradually disappear without their use. In the last stage of the disease, when the urine assumes a dark-brown or black colour, no remedy seems to have any efficacy, the animal is sunk beyond recovery, the bowels lose their action, suppression of urine follows, the animal stretches itself out and dies, as if perfectly exhausted. It is the duty of the owner, then, to attend to the disease at its commencement, and pursue a determined course of practice. Whether the disorder be owing to absorbed inspissated bile, diseased manyplies, or disease of the secerning glands, purgatives of any kind, profusely diluted with water, almost always effect a cure." Some good practitioners, especially when constipation and excitement have occurred before they can prescribe, begin with letting blood, and purge with a mixture of Epsom salt, flowers of sulphur, powdered ginger, and carbonate of ammonia, and, after purgation is fairly established, administer mild stimulants or nourishing drinks.

Red water, both in cattle and in sheep, is often popularly confounded, both in name and in symptom, with inflammation of the kidneys and inflammation of the urethra or of the mucous membrane of the bladder. The urine discharged in these diseases is mixed with blood, but not so intimately as in redwater, and generally with more or less accompaniment of mucus. Inflammation of the bladder or of the kidneys may easily be distinguished by this difference in the bloodiness of the urine; and, like every other case of acute inward inflammation, must be attacked with copious bleeding and with purging, yet must either not at all or very cautiously be assailed with counter-irritation. See the article Inflammation.

Red water in sheep is less precisely understood, as to either cause or nature, than red water in cattle; and it sometimes bears the name of resp, and sometimes that of water braxy. "Some persons," says Mr. Cleeve, in his Prize Essay on the Diseases of Sheep, "treat this complaint as inflammation of the kidney. It is extremely probable that, in all cases of red water, the inflammation of the abdomen may extend to the region of the kidney, and thus some of the indications that appear may lead the observer to suppose that the kidney is the primary part affected; but my opinion, founded upon post-mortem examination of the subject, is, that the inflammatory action has its origin in the peritoneum, and, consequently, that change of diet and attention to the bowels are the first points to which the care of the shepherd should be directed. If this opinion is well founded, diuretic medicines are not judicious. Feeding on turnips when covered with hoar-frost is supposed to occasion the complaint. Another, yet more probable, cause may be folding sheep on wet soil during frosty nights. The progress of this disease, as indeed is the case with all acute inflammation, is very rapid; so rapid as to occasion death in most instances before the existence of it is suspected. Where its progress allows of observation, the indications of it are costiveness of the bowels and great pain and distress; the animal appearing incapable either of rest or active motion from the violence of its sufferings. Its name is derived from an accumulation of bloody fluid in the abdomen. The remedy is, as I have already mentioned, copious bleeding, even until fainting takes place, and this followed by opening medicine: but it is so rarely the case that a cure can be expected, that, if the sure symptoms of it are perceived, the best way is to kill the sheep before they have obtained their height. Where I have succeeded in removing the inflammatory symptoms, I have immediately changed the food, and put the sheep on bran and oats, very liberally sprinkled with salt. I also

provide water very copiously. Red water has sometimes been called 'Watery Braxy,' but I apprehend that the braxy is more properly a retention of urine, proceeding from inflammation of the bladder, as the dry braxy is another name often applied to inflammation of the bowels. I never met with a case where a ewe laboured under retention of urine. When it occurs it most frequently attacks rams, and many valuable sheep have been lost from its effects. I have remarked it to have been generated by placing them on clover that had previously been mown. As it may be easily detected by the distension and tenderness of that part of the body externally, the water can be successfully drawn off by a catheter. It may not be unnecessary to caution the shepherd that diuretic medicines are most injurious in a retention of urine, as they increase the secretion of the fluid without in any way facilitating the discharge." See the article BRAXY.

RED-WING, or MAVIS,—scientifically *Turdus Gliacus*. A British song bird, of the thrush genus, and passerinous order. It arrives from the north and north-east of Continental Europe in the latter part of October, and remains in Britain through the winter. Its total length is about $8\frac{3}{4}$ inches. The upper part of the head and neck, the back, the rump, and the upper tail-coverts are uniform clove brown; the chin, the throat, the belly, and the under tail-coverts are dull white, tinged and streaked with brown; and the sides of the body, the under wing-coverts, and the axillary feathers are bright reddish orange. This bird inhabits wooded pleasure-grounds; and passes in mild weather into pastures and meadows; and feeds on worms, larvæ, and slugs.

RED WOOD. See CEANOTHUS.

REED. See ARUNDO.

REED-GRASS. See CANARY-GRASS.

REEL. The instrument on which a gardener's lines are wound; also, the instrument attached to the butt of an angling-rod for winding in the fishing-line.

REGULUS. A genus of song-birds of the warbler family and passerinous order. The kinglet or golden crested regulus, *R. amicapillus*, is one of the smallest of British birds, and remains in this country throughout the year. Its total length is about $3\frac{1}{2}$ inches. The forehead is greyish white; the crest feathers are bright yellow, tipped with orange; the back and the upper tail-coverts are olive green, slightly tinged with yellow; and the wing and the tail feathers are brownish black, edged with greenish yellow. This bird most commonly frequents fir plantations, and builds on the branches or twigs of the fir-tree; and it feeds on insects, seeds, and small berries. The eggs amount to from 6 to 10, and have a pale reddish white colour.

The fire-crested regulus, *R. ignicapillus*, is not so common as the preceding species, and is about half an inch longer, and has three dark lines and two light ones on the side of the head, while the golden-crested regulus has only one black line. Its crest also is of a much more vivid red colour; and its tail feathers are longer.

REIN-DEER. See DEER.

REINS. See BEARING-REIN and BRIDLE.

RELHANIA. A genus of ornamental, small, evergreen, Cape-of-Good-Hope undershrubs, of the sunflower division of the composite order. Five or six species, all yellow-flowered, and loving a soil of peaty loam, and propagable from cuttings, and varying in height from 6 to 24 inches, have been introduced to British gardens; and upwards of a dozen more are known.

RENANTHERA. A genus of ornamenal, tropical, epiphytous plants, of the orchis order. The scarlet species, *R. coccinea*, is a native of China, and was introduced to Britain in 1816. It was long known to fame as one of the most magnificent flowering plants in the world, and is now celebrated as one of the most splendid beauties of our most select stove collections; but it requires peculiar and nice treatment in order to be brought to bloom. It has long fleshy tortuous roots, and long leafy stems, and veinless fleshy leaves, and vast panicles of scarlet flowers; and it commonly attains a height of about 8 feet, and blooms from March till May, but may be so managed as to be kept in high and even perfect flourish during about four months. It succeeds best in peat mixed with reduced potsherds, and requires a high play of combined heat and moisture; and when 6 or 7 feet high, it must be placed in full exposure to the sun's direct rays, and occasionally washed over in the afternoon with a syringe. It is propagated from shoots or young branches, taken off and potted in moss. The name renanthera alludes to the kidney-like shape of the pollen masses.

RENCALMIA. A genus of ornamental, white-flowered, evergreen, herbaceous, greenhouse plants, of the iris order. Three species, varying in height from 12 to 24 inches, and all blooming in spring, and thriving best in a soil of peaty loam, have been introduced to Britain from New Zealand and Australia.

RENNET, or RUNNET. A liquid preparation for coagulating milk. See the articles CHEESE, MILK, and BEDSTRAW. The best rennet, and by far the most commonly used in Britain, is a peculiar infusion of the inner coat of a calf's stomach; and this is prepared in different ways in different districts, and has a diversity of power and quality dependent on the method of preparation. The Gloucestershire method, as described by Mr. Marshall, may be regarded as a fair specimen of the English methods; and the Ayrshire method, as described by Mr. Aiton, is at the same time the prevailing method throughout the Scottish Lowlands. Mr. Marshall says:—"Take the maw of a newly killed calf, and clean it of its contents, salt the bag, and put it into an earthern jar for 3 or 4 days, till it form a pickle; then take it from the jar and hang it

up to dry, after which it is to be replaced in the jar—the covering of which should be pierced with a few small holes to admit of air; and let it remain there for about 12 months. When wanted for use, a handful each of the leaves of sweet briar, dog-rose, and bramble, with 3 or 4 handfuls of salt, are to be boiled together in a gallon of water for a quarter of an hour, when the liquid is to be strained off and allowed to cool. The maw is then to be put into the liquid, together with a lemon stuck round with cloves; and the longer it remains in it the stronger and the better will be the rennet; half a pint, or less, of the liquor, is sufficient to turn 50 gallons of milk." Mr. Aiton says:—"When the stomach, or bag, is taken from the calf's body, its contents are examined, and if any straw or other food is found among the curdled milk, such impurity is removed; but no part of the chyle is suffered to be lost. At least two handfuls of salt are put into the bag, and upon its outside, after which it is rolled up in salt, and hung near a fire, where it is always allowed to hang until it is well dried, and it is understood to be improved by hanging a year, or longer, before being infused. When rennet is wanted, the 'yirning,' as it is called in Scotland, with its contents, is cut small, and put into a jar with a handful or two of salt; and a quantity either of soft water, that has been boiled, and cooled to about 65°, or of new whey taken off the curd, is put upon the bag in the jar. The quantity of water, or whey, to infuse the bag, is more or less according to the quality of the 'yirning.' If it is that of a new dropped calf, that has not been fed, 3 English pints will be enough; but if he has been fed for 4 or 5 weeks, a couple of quarts may, at least, be put on the bag to mash: it should, however, be observed that the 'yirning' of a calf 4 weeks old yields more rennet than that of one twice that age. After the infusion has remained in the jar from one to three days, the liquid is drawn off, and an English pint more water, or whey, put on the bag in the jar; and that, after standing in mash one or two days, is also drawn off, and, with that of the first infusion, strained, if any impurities appear in the liquor: the whole being put up in bottles for use as rennet, and the bag being thrown on the dunghill, without ever being put into the milk. Some put about a dram of good whisky into each quart bottle of the rennet; and it may be either used immediately, or kept for as many months as may be convenient."

RENT. The sum of services, produce, or money paid for the use of lands or tenements by the occupier to the owner. The word primarily denotes a return for advantages enjoyed; and is derived from the word *reditus* in its corrupted form of *renditus*. In feudal times, the rent of land arose out of the peculiar character of the tenure, and was paid in military services and rural labours; and in remote or primitive districts at the present day, it is controlled by the paucity of a circulating medium or by the general poverty of the agricultural community, and is paid partly or wholly in produce of the soil and in personal services. But in all enlightened, improved, and prosperous districts, even where it bears a name of produce, or is in any way determined in amount by the fluctuating circumstances of produce, it is now paid entirely in money. In an economical view, rent is either natural or covenanted; and in a legal view, it is either rent-service, rent-charge, or dry rent. A natural rent is the sum rendered due by the mere fact of occupancy, or of the raising and reaping of produce;—and is determined by the quantity of the produce, the price of the produce, the costs of cultivation, and the resulting profits of the occupier, and therefore varies every season; and a covenanted rent is the sum agreed to be paid by mere arbitrary agreement, and rests on hypotheses of the anticipated proceeds of occupancy, and may be either fluctuating or constant in amount, according to the conditions of the agreement. A rent-service is paid partly in money and partly in personal services; a rent-charge is a sum of money covenanted to be paid for occupancy of land under a clause of distress for non-payment charged on the land; and a dry rent or rent sec is the same thing without any clause of distress.

The amount of the rent of land, in general, is controlled by the wealth of the country, the number and employments and wants of its population, the distance of markets, the means of conveyance, the competition of farmers, the amount of public burdens, the price of produce, and other less important circumstances; and the amount of the rent of any particular farm, is controlled, in addition, by the nature of the soil, the condition of the fields and fences and drainage, the duration of the tenure, the conditions of the lease, the capital required to be invested in stocking and cultivation, and the peculiar or local expenses which the farmer must incur. Less rent can be paid proportionally for poor than for rich soil, in consequence of the costs of tillage and seed being nearly the same, and of both the quantity and the quality of the produce being inferior; less for any land under a short lease than for the same land under a long one, in consequence of the shortness of the time not allowing the farmer to do his best in improving the soil, and in working it up to a maximum produce; less for any land under fettering conditions than for the same land under free ones; less under circumstances of cultivation or locality or marketing which entail comparatively great current expenses than under circumstances which entail comparatively small ones; and less when the farmer has a capital barely sufficient for the current working of the farm than when he has an ample capital both for all current purposes and for the meeting of any emergency.

The amount of rent which is equitably due

from any land, or the proportion of the produce or of its value to which the landlord has an equitable title, is a question of great intricacy, and involves a vast number of variable and sometimes conflicting elements. Many attempts were made, in the times of the old routine husbandry, to reduce it to a standard and uniform rate; but even then they differed so widely in result, that some writers held one-fifth of the produce of arable land to be a fair amount for rent, while others contended for so much as one-third; and now they are made twenty-fold more conflicting, and rendered all but totally impracticable, by the great improvements which have been achieved by means of draining, irrigation, superior implements, agricultural chemistry, comprehensive rotations, and general enlightenment in all the principles of both economics and science which control the interests and practices of farming. Two farms, naturally possessing the same characters of soil and the same advantages of situation, may be in such widely different artificial conditions, that the one would be cheap at double the rent of the other; and two farmers, who have enjoyed the same routine advantages of mechanical training, or who might be pronounced equally good practical men, may differ so widely in the knowledge and control of the nice powers of improvement resulting from modern discovery, and from scientific calculation, that the one could well afford to pay a very high rent for any piece of good land, while the other might hold it at a moderate or even low rent, and nevertheless be a loser. Yet the equitable rent is clearly leviable from only the land itself, or from such attributes of it either natural or artificial as it possesses at the time of being let, and cannot, in any degree, be due from the results of either the superior intelligence, the superior industry, or the special improvements of the tenant. The simple surplus produce of land, in the state and under the conditions of its being let—or the profit which remains after the payment of all costs, and after a fair allowance for the risk and interest of capital and for the time and labour of the farmer—this alone is rent; and, when seen in such naked simplicity, it almost looks a more subtle and undeterminable thing than when complicated with all the general principles of economy and farming; for the very total produce of farms, whether as to annual amount or as to average value, is so very fluctuating as to keep the whole frame-work of society in continual vibration,—and therefore the *surplus* produce, which at one time may be no surplus at all and at another may be an overflowing one, and which at all times varies so mightily with local and peculiar circumstances, is surpassingly difficult to be forecast or precalculated, so as to be fixed beforehand in the form of rent. Yet approximations can be made; and these, to the utter exclusion of precedents, examples, and arbitrary rules, ought to guide both landlord and tenant.

"In Scotland," says Sir John Sinclair, "the following table of rent on arable farms states what is considered to be a fair proportion, where the land is cultivated:—

	Per English Acre.
1. Where land produces £10 10s. per acre per annum, one-third, or .	£3 10 0
2. Where land produces £6 12s. per acre, one-fourth, or . .	1 13 0
3. Where land produces only £4 5s. per acre, one-fifth, or . . .	0 17 0

In regard to grazing farms, they are let on principles totally different from the arable, namely, according to the quantity of stock they can maintain; and as they are not liable to the same expense of management, both the landlord and the tenant receive larger shares of the produce, than in the case of arable farms. In England, on the other hand, the husbandmen and their landlords are in a kind of partnership, in which the tenant provides all the capital, and undertakes the management of the whole concern; as a remuneration for which, and for the interest of the money he has invested in it, he is allowed, on arable land, equal to what is considered to be one moiety of the surplus, after defraying the expenses of cultivation, the taxes to which he is liable for the farm he occupies, and every other outgoing. Hay land requires much less of his attention, and for this he only obtains one-third of the surplus. But the profits of grazing, depending much on superior judgment in buying and selling stock, as well as skill in preventing or curing their diseases, the grazier is entitled to a share of the surplus fully equal to that of his landlord. It has been contended, as a general principle, that as both the expense of cultivating land, and the value of its produce, are infinitely various, a farmer ought to calculate what profit he can make on his whole farm, without entering into details; it being of little consequence to him, whether he pays at the rate of £10 or 10s. per acre, provided he makes an adequate interest on the capital invested. That is certainly a fair criterion on which a tenant may calculate what he ought to offer; but a landlord, in estimating the rent he ought to insist on, must take into his consideration the produce that his land is capable of yielding, and what proportion of it, or of its value, at a fair average, he has reason to expect, under all the circumstances of the case, which ought not entirely to depend on the exertions of a timid or penurious tenant. What are the profits to which a farmer is entitled, is a subject of much dispute. On the one hand it is contended, that the produce of land is of such universal and absolute necessity to the existence of mankind, that it is not reasonable it should yield to him who raises it more than a fair profit. On the other hand it is urged, that a farmer is entitled to be fully recompensed for the application of a considerable capital, exposed to the uncertainty of the seasons, when it is managed with economy and conducted with industry

and skill; and it has also been observed, that it is seldom more money is got by farming than an adequate interest for the capital invested. This is owing to competition, the articles produced being in numberless hands, who must bring them to market,—and necessity, the goods of the farmer, being in general of a perishable nature, on the sale of which he depends, for the payments he has to make and the subsistence of his family. To prove how moderate the profits of farming in general are, it appears from the most careful inquiries, that on arable farms they rarely exceed from 10 to 15 per cent. on the capital invested, which is little enough, considering that few employments are more subject to casualties than farming, or require more uniform attention. Some arable farmers, possessed of superior skill and energy, and who have got leases on reasonable terms, may clear from 15 to 20 per cent.; while others, who are deficient in these qualities, or pay too high rents, frequently become insolvent. In grazing farms the case is different, as they are attended with less expense of labour, and produce articles of a more luxurious description, for which a higher price will be given. Hence, in such farms, 15 per cent. and upwards is not unusual. Besides, the grazier is more of a merchant than the mere arable farmer,—is frequently buying as well as selling stock, and sometimes makes money by judicious speculations, though occasionally, from a sudden fall of stock, his losses are considerable. The grazier who breeds superior stock, and thence incurs great expense, is certainly well entitled to more than common profit for his skill and attention. It has been observed, however, that a farmer seldom makes much money, unless he is most advantageously situated in the neighbourhood of a great town, or unites with farming some other profitable employment. But those who have capital and ability adequate to the management of more than one concern, merit to be amply rewarded for their superior skill and industry."

Bayldon's mode of ascertaining the equitable rent of any ordinary piece of turnip land is to select one acre of the best in cultivation,—to value the labour, expenses, and produce through a four years' course of husbandry, of turnips, barley, clover, and wheat,—and, after taking an average of the profit, to deduct 10 per cent. for interest on the capital afloat, and set down the remainder as rent. "The same plan," says he, "may be adopted in the case of clays; and when a value is thus formed of the best and worst land on the farm, the intermediate qualities of the other fields may be readily valued by any person who understands the valuing of land. The sum of 10 per cent. on the capital expended on perishable stock, is much too low a rate of interest for such risks; and 15 and even 20 per cent. have been mentioned as not more than equal to the attention the business requires, and to the tear and wear and casualties of the concern. Some writers allow 10 per cent. for interest on capital only, and leave the farmer to find a remuneration for his time and attention from his exertions in business. The expenses and maintenance of the family are also allowed to arise from his and their industry, which would amount to 10 per cent. more. From strict inquiry and due examination, it would appear that the farmer is justly entitled to 20 per cent.;—to 5 per cent., which interest he could obtain from his money, and leave his personal attention unoccupied, to 5 per cent. for casualties, and deterioration of property in the shape of perishable stock, and to 10 per cent. for his time and exertions in the occupation. Thus, if a farmer expend £1,500 on a farm of 250 acres, he will require £75 for common interest, and £75 for casualties, and £150 for himself and family, a sum he and others may expect from devoting their undivided time and attention to any other business. On small farms, the tenants do a great part of the work themselves, and on extensive farms, their fullest attention will be required in directing and superintending. On the subject of the per-centage due from capital employed, very different opinions have been entertained; but it seems a fair and just conclusion to allow the farmer such profits as are derived from other professions, and 10 per cent. is sufficiently moderate. Five per cent. for casualties is also low enough, and the other 5 per cent. may be disputed, as it may be urged that the farmer could not engage in any other business without his capital. But if he be possessed of such a sum of money as would at 5 per cent. afford him a livelihood, he is fairly entitled to that interest from the business to which he applies it, along with an additional per-centage for his time and attention. The lowest calculation cannot be under 15 per cent., though my own opinion would allow him 20,—viz. 15 for profits on capital and time, and 5 for casualties."

Another question of great importance and of much intricacy is, whether the rent of land should be fixed or fluctuating,—or, in other words, whether it should be uniform in annual amount through a series of years, or should vary from year to year according to circumstances. It is commonly but improperly termed a question of money-rent or of corn-rent,—the fixed rent being called a money one because independent of anything but the mere terms of agreement, and the fluctuating rent being called a corn one because usually dependent for its variations on the fluctuating produce or prices of corn. It is a question of no concern to parties who take land from year to year upon a new annual valuation,—and of not very great moment to parties who take land for periods of only two or three or at most four years upon a valuation of the four preceding years' proceeds; but it possesses great consequence to tenants at will who continue to occupy, for an indefinite period, upon the same terms as in the first year of their

tenancy,—and still greater to extensive and enterprizing farmers who take lands upon leases of from ten to fourteen, and especially of from nineteen to thirty years. The natural rent of land for a single season can be calculated with a probability of sufficient accuracy to justify the offer and acceptance of a fixed sum; but the covenanted rent, for so long a period as that of almost any good leases, cannot be calculated, on the principle of a fixed sum, except in the way of the most obscure conjecture or of bold, reckless, and exceedingly dangerous speculation. The fluctuations and reverses which the agriculture of Britain has undergone, even in periods of the least disturbed progress of legislation and commerce, but especially at times of revulsion and upheaval in national politics and in international connexions, have repeatedly tossed all the arrangements of the country which were based on fixed rents into a state of chaos, and involved the pecuniary condition of a large proportion of the agricultural community in inextricable confusion or in utter ruin. In one state of things, the landlord or the tenant acquires an excessive gain, which leads to prodigality; in the opposite state of things, he suffers an excessive loss, which may prove destruction; and in either state, the harmony of interests and the consequent well-being of general society are disturbed or overthrown. In many of the best farmed districts of Britain, therefore—particularly in the north of England and the Lowlands of Scotland, where the long-lease system prevails—the adoption of a fluctuating rent, instead of a fixed one, has become pretty general and is much approved.

The chief argument in favour of a fixed rent in all cases, and against a fluctuating one in any, is that, however ill a covenanted fixed rent may be adapted to the times, or however widely it may occasionally differ from the natural or equitable rent, yet, in consequence of being a known and exact amount, it both checks and regulates the expenditure of the tenant and sets certain bounds to the expectations of the landlord. "Now as to the tenant, it appears to us that he is better enabled to regulate his expenditure by knowing the quantity, or nearly so, of his produce, say the number of stacks of wheat, which he must lay aside as rent, than by knowing the sum of money when he is yet ignorant what proportion that sum will bear to the gross return from his farm. As regards the proprietor, again, we conceive that the virtual value of his income is fully as steady when made up of produce-rents as money-rents. This results from the fact that the staple products of the country, such as corn, butcher-meat, and wool, are the chief regulators of the value of money. Thus, if the proprietor's income be regulated by these, or even by the most important of them, he may calculate on being able always to obtain out of it pretty nearly the same quantities of the necessaries and even of the luxuries of life. But even if it were some advantage in ordinary cases for both parties to know the amount of money in place of produce which they have to give and receive, such knowledge can be of little consolation to the tenant when that money becomes double of what he would give, or to the proprietor when it is only half of what he would get, were a new bargain to be made. That such cases have often happened with farms let on fixed money-rents, during the last half century, no one in the least acquainted with the history of British agriculture will deny. There appears, therefore, to be no such advantage in a constant rent over a fluctuating one, from the mere fixedness of the one over the variableness of the other, as to make us prefer the former, if the latter can be better proportioned to the means of paying it."

A fluctuating rent, however—in order to its maintaining a near approximation to a natural rent, or in order that it may not involve irregularities and disadvantages nearly as great as those of a fixed rent—must either be understood with considerable limitations, or calculated with express reference to particular farms or districts, or determined by very comprehensive principles. "The amount of rent for improvable and well-cultivated farms," remarks Sir John Sinclair, "does not depend so much on the price of grain, as is commonly imagined. A large proportion of such farms usually produce green crops, the value of which depends upon the prices of beef, mutton, and wool, and not on that of grain. Various circumstances also may arise, which may reduce the price of particular sorts of grain below its usual level (for example, barley, when the distilleries are stopped); or may raise it disproportionably much higher, in case a large proportion of the wheat crop should be destroyed by rust or mildew." In consequence, too, of depressed prices commonly proceeding from an abundant harvest, and exalted prices from a deficient one, a fluctuating rent determinable simply by the current price of corn might be lowest when the farmer has most to give and highest when he has least, so that the landlord might suffer in years of plentiful produce and low prices, and the tenant in years of scanty produce and high prices, and the interests of the two be made to work against each other to the eventual and serious injury of both.

One contrivance for checking the irregularities of the system is to make only one half of the total rent fluctuating, and to make the other half fixed; and this has been found pretty satisfactory for both tenant and landlord in most cases where a considerable portion of the total produce arises from green crops, grass, and live stock.—Another contrivance is to determine the total fluctuating rent of each year by the average of prices during the preceding seven years; and this, of course, prevents any disarrangement from any one great and sudden rise or fall in the market, but, at the same time, is no check whatever upon an aggre-

gate advance or retrogression in prices, or upon any great aggregate change in the relative values of labour and produce, during any one septennial period of a lease as compared to any other septennial period.—A third contrivance is to fix a maximum and minimum price for the particular grain, whether wheat or oats or barley, or two or all of them, by which the amount of rent is determined; and this so operates that the tenant pays no rent for any price above the maximum, and the landlord sustains no deduction for any price below the minimum.—But all these contrivances, as well as modifications of them, are mere checks, and take for granted a radical deficiency in the method of calculating the fluctuating rent, and are themselves subject, though in a much less degree, to the very same kind of irregular tendencies which they are designed to control. An incomparably better method is to calculate on such comprehensive and searching principles as shall make the fluctuating rent always coincide with the natural or equitable rent, or as shall cause it to vibrate in perfect accordance with the aggregate surplus productiveness of the farm; and this would, no doubt, have been everywhere adopted from the beginning, if the requisite principles for truly determining the rent could have been found,—and will readily be adopted still if the principles can now be satisfactorily made out. We therefore gladly transfer to our pages what we think an important approximation to them, in an able article of the Journal of Agriculture, published in January, 1846:—

"It is clear that either acreable quantity of produce, or price of produce, or both together, are the facts to be taken as the regulators of the fluctuations of rent. We fix upon these, because, among other reasons, the expense of cultivation and the profit due to the tenant, though equally important with these in determining rent, are subject to much smaller and less sudden fluctuations, so that their influence can be more easily estimated beforehand. Before discussing, however, whether both these facts regarding produce (viz., acreable quantity and price) should form the basis of fluctuating rents, several intermediate inquiries suggest themselves.

"Of these the first is—Can we carry the principle of fluctuation so far into practice as to make the portion of the rent fluctuate which is dependant upon animal as well as that which is dependant on vegetable produce? The entire rent of a farm is sometimes regulated by grain, on the plea that the price of stock usually fluctuates in accordance with that of grain. A correspondence, more or less close, between the two may, no doubt, be observed over an average of several years, yet there is often, perhaps generally, such a discrepancy between their fluctuations in one or two seasons, as would render a rent calculated from the one a very false representative of that naturally payable from the other. The rent payable from stock, therefore, ought not to be regulated by grain. The regulation either from the value of stock or from the acreable value of the crops which produce the grain, is evidently the natural expedient. The former of these, for many reasons, would be extremely difficult to determine satisfactorily. One of the most obvious reasons is the universal practice of selling cattle by dead weight, which is estimated merely by the eye. Then there are so many different breeds of cattle brought into the market, and in so very different stages of ripeness, that it would be difficult to fix their average value. Still it seems possible to estimate judicially an average on the price of stock sold in the principal markets, and the average of such markets as Smithfield would form a good criterion of the price of fat stock. But we must here apply by anticipation to stock-rents, a principle which we shall afterwards expound as a fundamental one of all fluctuating rents. By this principle we conclude that, if such rents are to fluctuate, it ought not so with the price of stock merely, but also with the quantity produced. The average acreable value of stock-feeding crops is, therefore, the fact, rather than the average price per stone of beef, mutton, or wool, which ought to be determined to regulate fluctuating rent payable from stock. Turnips, grass, and other stock-feeding crops being often sold by the acre, we see no impossibility in determining their acreable value in a similar way as grain-crops. But as we consider the application of the above principle to the rent from grain of the most importance, and there is, as yet, little prospect of that being effected, we need not here press the further extension of the principle. We therefore conclude that there is no immediate prospect of making the portion of rent dependant on animal produce fluctuate on a proper principle.

"This being the case, our next inquiry is—How ought the rent, payable from stock, the constant portion, to be proportioned to the whole rent? This depends on the rotation of cropping followed, as it regulates the proportion of income derived from stock; but even with a knowledge of the rotation, it is exceedingly difficult to determine this point. A perfect separation, indeed, of the two sources of rent is impossible, even by inspection of the most accurately kept accounts. This arises from a great part of the produce of one source being made to promote that of the other without a valuation being possible; and besides the difficulty of estimating accurately the value of straw, dung, &c., thus passing from one member of the rotation to another, it is still more impossible to say exactly what proportion of the expense of labour ought to be charged against each. We are inclined to think, however, that the benefits mutually given and received by the grain and stock-feeding crops, ought, under proper cultivation, to be pretty nearly balanced, and that the share of the expense which ought to be charged against each is nearly in proportion to the gross return yielded by each. On this supposition, the share of the rent determined from the average value of stock, (or fixed at a sum of money, if no such value has been judicially determined,) and that from grain, ought apparently to be in proportion to the gross return from sales of stock and of grain. This conclusion, however, must be modified by the consideration that the money obtained for stock is the return from a proportionally larger capital than that obtained from grain, and therefore its proportion for rent ought to be less. On this account, in place of taking the gross return from sales of stock, the value that would be obtained by selling the stock-feeding crops to be eaten on the premises ought to determine their portion of the rent. This mode would have the advantage of being a simpler guide than the value of the stock sold in any year, because that seldom corresponds exactly with the money received for them. In making an offer, therefore, of a rent partly constant and partly fluctuating, for a farm intended to be cultivated on a certain rotation, an estimate would first require to be made of the average value in several previous years of its grain and stock-feeding crops. The average sum thus naturally payable out of these taken together would then fall to be com-

puted as rent. This average might then be adopted as the supposed average of future years, or at least it would afford data from which the future average natural rent might be formed. The sum, then, to be fixed as the constant part of the rent, representing that dependant on stock, ought to bear the same proportion to the supposed entire future average natural rent as the value of the stock-feeding crops bears to the value of the whole produce of the farm. The portion of the rent thus payable for stock must, of course, be much less where bare fallowing is practised than where the whole fallow division bears a crop.

"We have now to inquire—What is the species of grain by whose acreable quantity or price, or both, the fluctuating portion of rent is likely in future to be chiefly regulated? All the grain and also pulse crops (which in this case may be classed together) ought properly to enter into this calculation in the proportion in which they are intended to be grown on the farm in question; yet, as the prices of all sorts of grain fluctuate pretty much in unison, fluctuating rents are sometimes regulated by the most valuable grain alone, provided it is the chief product of the farm, since it is at the same time the product whose price most influences that of other commodities, as also the rate of wages, &c. We do not mean to recommend this practice, yet, in justification of it, we may state that by the average imperial prices of wheat, barley, and oats, from 1771 to 1842 inclusive, as given in M'Culloch's Commercial Dictionary from parliamentary returns, we find that the fluctuation in the relative prices of these is very small when compared with the immense fluctuations in the absolute price of each. Within the period above mentioned, the price of wheat fluctuated about 364 per cent., that of barley 391 per cent., and that of oats 314 per cent. The fluctuations, on the other hand, in the relative prices of these grains within the same period scarcely amounts to 100 per cent. Comparing the price of barley with that of wheat, we find that the former was always more than one-third, and only once reached two-thirds of the latter; and comparing oats with wheat, we find that the former was always more than one-fourth, and never reached one-half, the price of the latter. The fluctuations in the relative prices of these grains, though very considerable, being thus much less important than the absolute fluctuations of each, the assumption of the species chiefly grown as the representative of the whole, in annually regulating the rent, ought to be a smaller source of error than in following the price of any, or all of them, in past years, in fixing the rent during a long series of future years. This latter course is followed in fixing a constant money-rent. It need not, therefore, appear objectionable if, for simplicity and other reasons, one species of grain should be taken as the sole basis of calculation of a fluctuating rent, where such species greatly predominates as a marketable product of the farm. At all events, it cannot be out of place to inquire here what ought to be regarded as the most important grain product of the country, whether with a view of its being the sole or (on a more accurate system) the chief regulator of the fluctuating portion of the rent of good arable land. Wheat has hitherto held this place. Let us therefore examine whether there is any likelihood of a change in this respect. A very common conclusion in the complaints of farmers of late years of a fall in the value of agricultural produce, has been the expression of the opinion that they cannot afford to grow wheat below a certain price, usually the lowest they have experienced up to that time. Nor is this merely a vague mode of talking; for such an opinion has been maintained on oath by many of the most eminent agriculturists of the country. Thus, before the parliamentary committee on agricultural distress in 1836, when prices were much the same as they were in the early part of this season, almost every witness stated that a price of wheat varying from 40s. to 65s. per quarter according to locality, rent, skill, and other circumstances, was that below which he considered he could not afford to cultivate it; and many distinctly stated that, should it fall below that price, its cultivation must be abandoned for other grains. Now, though we deprecate any measure tending, by great and sudden reduction in the price of grain, to throw part of the land now so employed into pasturage, and thus diminish the quantity of farinaceous human food, yet we cannot enter into those views which would deter us from the cultivation of wheat only. We see no reason, from the experience on the subject alluded to, or on any other ground, to expect wheat to fall in price without a somewhat proportionate fall in the prices of other grains. Now supposing our three chief kinds of grain to continue to bear the same ratio in price which they bore on an average during the period above spoken of, the return from the cultivation of them on land well suited for each would be as follows:—

Wheat.
63s. per quarter.
4 quarters per acre.
252s. per acre.

Barley.
33s. per quarter.
5 quarters per acre.
165s. per acre.

Oats.
23s. per quarter.
6 quarters per acre.
138s. per acre.

These prices may be considerably more than can be calculated on for the future, but their proportion to each other cannot be greatly altered; wheat ought always to yield the greatest return. But it may be objected that wheat is the most exhausting crop. We answer that it is at the same time the most restorative crop; because, while the quantity of grain, the only part not returned to the land, is less bulky from wheat than from barley and oats, in the proportion of four to five and six, its straw is more bulky in nearly the same ratio. If the argument against wheat be put in another shape, and it be said that it incurs more expense both in work and manure than any other crop, we ask what does this objection amount to? Merely to this—That wheat (except after grass) must be preceded by a highly manured fallow—either a bare fallow, which pays nothing, or turnips, potatoes, or other drilled crops, which often scarcely pay. Admitted. But are not fallowing and manuring necessary to keep the land clean and in proper condition, whatever sort of crop may follow—necessary for good grass, which, again, must carry good stock, that the following oat-crop may also be good—not to speak of the direct benefit which the succeeding crops may derive from the fallow-applied manure still inert in the soil? This reasoning, with some alteration of terms, applies as well to every course of cropping as to the five years course which we have had in view. If, then, such a system of cultivation is necessary for other crops as well as wheat, it is surely absurd to say that the crop which gives the greatest return for the outlay is the one which only cannot be afforded to be grown. It would be as reasonable for a fisherman who had to keep up his full establishment of men, boats, and nets, to say that he could not afford to catch the most valuable sort of fish. Thus we believe, in

contra-distinction to the often-expressed opinion of the farmers themselves, that wheat will continue to bear as high a proportion in price to other grains as it bears at present, however much the cultivation of all may increase or diminish. In truth, we rather expect to find the proportion of wheat becoming every year greater on account of its being sown more generally after turnips, and of the extended tillage of the old grass-land of England, most of which is admirably adapted for wheat. On these grounds, then, we are of opinion that wheat is likely to continue to form the chief basis for calculating the fluctuating grain-rents of good arable farms.

"We have now arrived at this point of our inquiry—Whether ought the fluctuating or grain rent to be regulated by the average price alone, or by the average both of price and acreable quantity of grain produced throughout the district or county? We have already anticipated, so far, the answer to this question, by stating that, in the case of the share of rent payable from stock, if the rent is to fluctuate, it ought to fluctuate both with the average price and the quantity of stock, or of stock-feeding crops. Price alone, however, has hitherto been attended to in regulating grain-rents. This we consider to be a glaring defect in the system now followed, as applied to the present, and more especially to what we hope will be the future state of our grain markets. We consider such a system in many instances to be unfair to the proprietor and in others to the tenant. It is unfair to the proprietor when the crop of the county, and therefore, presumably, that of his own property, exceeds the average quantity of many years' crops in a greater degree than its price falls below the average, and for the tenant, when the crop falls under an average quantity to a greater degree than its price rises above the average. But, suppose the fluctuations in price to be exactly the reverse of the fluctuations in quantity, the present method is far from being a proper one for adjusting rent; because, were the price to fall in the same proportion as the acreable produce increased, the tenant ought still to have the same income from his farm, which being obtained at a smaller outlay, he would have a greater balance to pay rent from a large cheap crop than from a small dear one. Hence the present system of grain-rents is particularly unfavourable for the landlord when the crop is abundant and cheap, and equally so for the tenant when scanty and dear. Its only proper and justifiable tendency seems to be, to give the proprietor a share in the benefit from a rise in prices, when the rise is not produced by a deficiency of crop, and to protect the tenant against the entire loss from an unlooked-for reduction of price through an inundation of foreign corn. The extraordinary fluctuations in the price of grain in this country during the continental war were not caused entirely, or even chiefly, by corresponding variations in the quantity raised. The immense rise in price, on some occasions, was caused partly by bad harvests, but still more by the fear of their recurrence, whilst foreign supplies were almost entirely excluded, and by speculators being thus induced to diminish the supply for immediate consumption by storing grain. The sudden and great fall in price on more recent occasions was caused by the abundant home supplies being rendered still more abundant by a sudden opening up of foreign traffic. The prices of grain, under both these circumstances, and similar circumstances have happened in earlier periods of our history, varied much more than the quantity produced. The rent naturally payable, therefore, often depended more on the price than on the quantity, so that the regulation of fluctuating rents by the average price was the natural means to resort to. This system was adopted, and, no doubt, saved many a farmer from ruin, after the conclusion of the war, and where adopted, then, secured to landlords a fair share of the rise in the markets occasioned by the war. Having thus far supplied the necessity which called it into existence, the present system of grain-rents is gradually becoming less popular—people are beginning to think that the most natural state of the relation between landlord and tenant is to pay most for the use of land only when it produces the most abundant crops. Various modifications have been introduced in the mode in which the system of grain-rents acts; but they are all merely empirical cures for the evil, and founded on no sound principle. We, therefore, come to this conclusion—That unless both the first and second foundations of rent above laid down, that is, unless the county average of the acreable quantity, as well as that of the price of the regulating grain, be taken as an element in the calculation of fluctuating rents, these can never be properly adjusted. Indeed we conceive that, if one of the fundamental facts only is to be acted on, it ought in future to be rather the acreable quantity than the price of grain. We found this opinion on the consideration that there is a tendency more and more towards a free trade in corn, and that the more our markets are thrown open to the competition of agriculturists, from all climes and counteracting states of weather, the more steady should be the state of the markets; while we cannot suppose that the quantity we ourselves produce will by that competition be rendered more constant. We would by no means, however, be understood to propose that the quantity of produce should be taken as the sole regulator of fluctuating rents, but merely to predict that it will at some future period become a more important element than price in determining rent. The adjustment we propose is the number of bushels of grain forming the grain-rent, convertible into money by the judicial average price that should bear a constant proportion to the number of bushels per acre of the same sort of grain grown in the same year throughout the county. Such an adjustment of rents would have afforded an inexpressible consolation to farmers under the sad prospect forced upon them by the destructive rains in the month of July last. Then every farmer had the prospect of his income from the crop on the ground being much reduced; but tenants bound to pay in rent the price of fixed quantities of grain then felt the additional grievance of having their rents increased nearly in proportion to the destruction of their crops. They, we conceive, would have sufficient cause to deplore such a destruction, even were their rents slightly diminished on account of it. By the adjustment we have proposed, this diminution could only be slight; for the price of grain must always be increased by a failure of the crops, though by importation from abroad the increase may be prevented, being proportionate to the deficiency in the quantity produced. Thus landlords can have no ground of complaint, since their share of the calamity would be small.

"The arrangement proposed would give the proprietor and tenant their just shares of profit and loss from the general improvement of agriculture, without influencing the gain or loss due to the tenant for his peculiarly good or bad management. When his land is let on a constant money-rent, the proprietor's only benefit from the increased produce of the country, on account of general improvements in agriculture, depends on the frequent disproportionate increase in the value of money. When, on the other hand, it is let on the present mode of grain-rent, an increased produce by such means is rather a loss than a gain to him, by its reducing the price of grain more than that of other commodities, and consequently lowering his rental more than it raises the value of money. We see no reason why the proprietor should not share with his tenant in the varia-

tion of the productiveness of the soil, whether occasioned by the weather or by the application of science, as well as in the variation of prices. By this mode of paying rent, landlords would also derive the additional advantage of choosing skilful tenants, who, by increasing the produce of their farms would raise the average produce of the district, and consequently establish the means by which their rents would be increased. An inestimable benefit would result to the community from the adoption of this practice, by giving proprietors a more immediate pecuniary interest in increasing the produce of their estates and of the country around them, as also by its thus creating a strong inducement for them to reside on their estates. It may be objected that, by reducing rent as the average produce diminishes, there would a premium on bad farming be established. Such would be the case were the rent merely to vary with the produce of the farm for which it is paid; but when it is mainly dependant on the produce over a large district, the objection does not hold; for the influence of a scanty crop of one farm in reducing the average of the district would be so small, and the loss from it to the farmer so great, that the increasing productiveness of his farm would be as much an object to him under this as any other system of payment. It would thus present no temptation to relax his energies. One of the strongest arguments in favour of this particular system of fluctuating rents is, that, by proportioning their income to the state of the country, such a mode of rents would deprive proprietors of the most plausible argument against granting leases, and would, therefore, induce the practice with its numerous good consequences to be greatly extended. On these and other grounds, which it is unnecessary to state, we conclude that fluctuating rents ought to be regulated by the average both of price and acreable produce of grain throughout the county.

"We must now inquire, How can the annual average acreable produce of grain in each county be ascertained? The difficulty of determining this statistical fact is the only considerable obstacle to the reduction of this theory of grain-rents to practice; yet, though we cannot suggest any perfectly unobjectionable means for effecting the object, we are confident that, were the country generally as much convinced as we are of the many important uses (besides the regulation of rent) to which this information might be applied, means would soon be used for obtaining it. Sufficiently accurate data might perhaps be obtained by examining, on oath, a number of farmers from every parish in each county, on the average number of bushels of grain per acre grown on their farms in the previous season, in the same way as they are examined on the prices for which their grain is sold. Farmers would have no more difficulty in keeping an account of the quantity than of the price, and there would be as good a check on their statements of the quantity obtained as of the price for which it was sold. The maintenance and raising of their characters as agriculturists would, without any other check, be sufficient to prevent farmers from understating the acreable amount of their crops. We must, however, notice an objection which will very readily be urged against any such inquiry. It will be considered at first as of too inquisitorial a nature, and the disclosure of the rate of produce on individual farms will be said to be taken advantage of by landlords in reletting them, to the prejudice of the tenants in possession. Such a disclosure might be avoided before the public. At any rate, each witness would only be called on to disclose, at long intervals, the return from his farm, perhaps not more than twice or thrice during his lease. But even if a more ample disclosure were required, tenants would have much less ground of complaint against this than against the disclosure of their whole means and substance for the poor's-rate assessment, or that exacted of every class but themselves in respect of the income-tax act, and of which they complain of not being allowed to do in the same way as others."

REPRODUCTION. See PROPAGATION.

REPTILES. In the Linnæan arrangement, the class of cold-blooded vertebral animals which breathe by lungs, *amphibia*, consisted of two orders,—*reptilia*, having four feet, as the tortoise, frog, lizard, &c., and *serpentia*, having no external organs of motion. In Cuvier's classification the class of *reptilia* corresponds nearly to the *amphibia* of Linnæus, and is divided into the four orders of *chelonia*, tortoise, turtle,—*sauria*, crocodile, lizard, chameleon,—*ophidia*, serpents, boa, viper,—*batrachia*, frog, salamander, proteus, siren. Reptiles are distinguished from birds and quadrupeds by their cold blood and single heart (with only one ventricle), and from fish by their respiring through lungs. Their blood is never at a much higher temperature than that of the medium in which they live. No other animals are capable of enduring so great extremes of heat and cold as the reptiles, especially some particular species: frogs, for instance, have continued to live in the human stomach, and in lumps of ice. From the peculiar structure of their bodies, they are able to suspend their respiration for a considerable time, and are also endowed with the faculty of enduring an abstinence that would prove fatal to warm-blooded animals. Most of them can live in the air as well as in water. Many live indifferently in either element. Some pass a certain period of life, or certain seasons of the year, in one, and the rest in the other; and some, finally, are confined to the water, or to the land. They live chiefly in morasses, swamps and stagnant waters, damp, dark places, caves, and holes in the earth. As means of defence, nature has given to some of them great bodily strength, or sharp teeth, as to the crocodile; to others a deadly poison, as to certain kinds of serpents; to others a hard covering, as to the tortoise; to many a disgusting smell, or an acrid humour, which they eject. Some of them have a remarkable power of reproduction, by which they renew parts of the body of which they have been deprived. Some can live for an incredibly long time without air, and even without food, and some undergo transformations like insects. None of them chew their food, but they swallow it whole, and digest it at leisure. They are in general extremely tenacious of life, and will continue to move, and perform other animal functions, even after the severest injuries. Their colours and general appearance are, in most instances, disagreeable: some, however are decorated with the most vivid colouring. Their voices are either harsh and grating, or they are entirely dumb. Most reptiles are oviparous. In some, particularly in the frogs, the

eggs are not fecundated until after their expulsion from the female; hence they are merely provided with a thin membranous covering. The eggs of others, as the tortoise's, have a soft, tough skin, resembling parchment, while, in other genera, the eggs are furnished with a hard, calcareous shell. In those species which are viviparous, the eggs are regularly formed, but are hatched internally, as in vipers, &c.

The following arrangement of the *reptilia* is that given by the prince of Musignano; and, although it presents points of objection, these are as few as in any other attempt of the kind; added to which it is the latest:—

CLASS.

REPTILIA.

FIRST SUB-CLASS.

PULMONEA.

ORDER I.

CHELONII.

FIRST FAMILY.

TESTUDINIDÆ.

a Testudinina.

1. Testudo, *L.*
   Sub-genera, 3.
2. Terrapene, *Bonap.*
3. Kinosternum, *Bonap.*
4. Emys, *Bonap.*
   Sub-genera, 2.
5. Hydraspis, *Bell.*
6. Chelonura, *Flem.*

b Chelydina.

7. Chelys, *Dumer.*

c Trionicina.

8. Trionix, *Geoff.*

SECOND FAMILY.

CHELONIDÆ.

a Sphargidina.

9. Sphargis, *Merr.*

b Chelonina.

10. Chelonia, *Brong.*

ORDER II.

SAURI.

THIRD FAMILY.

ICHTHYOSAURI.

11. Teleosaurus, *Geoffr.*
12. Steneosaurus, *Geoffr.*
13. Ichthyosaurus, *Koenig.*
14. Saurodon, *Hays.*
15. Plesiosaurus, *Conybeare.*
16. Geosaurus, *Cuv.*
17. Megalosaurus, *Buckland.*

FOURTH FAMILY.

CROCODILI.

18. Crocodilus, *Cuv.*
    Sub-genera, 3.

FIFTH FAMILY.

LACERTIFORMES.

FIRST SUB-FAMILY.

LACERTIDÆ.

a Tupinambina.

19. Varanus, *Merr.*
    Sub-genera, 4.
20. Teius, *Merr.*
    Sub-genera, 6.

b Lacertina.

21. Lacerta, *L.*
    Sub-genera, 2.
22. Tachydromus, *Oppel.*

SECOND SUB-FAMILY.

STELLIONIDÆ.

a Agamina.

23. Uromastix, *Cuv.*
24. Cordylus, *Gronov.*
25. Stellio, *Daud.*
    Sub-genera, 2.
26. Agama, *Daud.*
    Sub-genera, 15.
27. Lophura, *Gray.*
28. Draco, *L.*
    Sub-genera, 2.
29. Pterodactylus, *Cuv.*
30. Chlamydosaurus, *Gray.*

b Iguanina.

31. Iguana, *Cuv.*
32. Ctenosaura, *Wiegm.*
33. Ophryessa, *Boie.*
34. Leiocephalus, *Gray.*
35. Basiliscus, *Daud.*
36. Polychrus, *Cuv.*
37. Ecphimotes, *Fitzinger.*
38. Ophlurus, *Cuv.*
39. Anolius, *Cuv.*
40. Mosasaurus, *Conybeare.*
41. Iguanadon, *Mantell.*

THIRD SUB-FAMILY.

GECKOTIDÆ.

42. Cirtodactylus, *Gray.*
43. Euplephoris, *Gray.*
44. Phyllurus, *Gray.*
45. Gymnodactylus, *Spix.*
46. Stenodactylus, *Cuv.*
47. Spheroidactylus, *Cuv.*
48. Ptyodactylus, *Gray.*
49. Phyllodactylus, *Gray.*
50. Thecadactylus, *Cuv.*
    Sub-genera, 4.
51. Hemidactylus, *Gray.*
52. Platydactylus, *Cuv.*
    Sub-genera, 6.

FOURTH SUB-FAMILY.

CHAMÆLEONIDÆ.

53. Chamæleon, *Daud.*

FIFTH SUB-FAMILY.

SCINCIDÆ.

54. Scincus, *Daud.*
    Sub-genera, 3.
55. Gymnophthalmus, *Merr.*
56. Spondylurus, *Fitz.*
57. Heteropus, *Wiegm.*
58. Gerrhosaurus, *Wiegm.*
59. Gerrhonotus, *Wiegm.*
60. Trachysaurus, *Gray.*
61. Cicigna, *Gray.*

SIXTH FAMILY.

ANGUIDÆ.

* Tetrapodi.

62. Seps, *Daud.*
    Sub-genera, 5.
63. Chalcides, *Daud.*
    Sub-genera, 4.

** Bipedi.

64. Bipes, *Lacep.*
    Sub-genera, 2.
65. Chirotes, *Cuv.*

*** Apodi.

a Anguina.

66. Pseudopus, *Merr.*
67. Ophisaurus, *Daud.*
68. Anguis, *L.*
69. Acontias, *Cuv.*

b Amphisbænina.

70. Typhlos, *Schn.*
71. Amphisbæna, *L.*
    Sub-genera, 2.

ORDER III.

SERPENTES.

SEVENTH FAMILY.

OPHIDII.

FIRST SUB-FAMILY.

COLUBRIDÆ.

a Ericina.

72. Anilius, *Oken.*
    Sub-genera, 2.
73. Erix, *Daud.*
74. Clothonia, *Daud.*

b Boina.

75. Boa, *L.*
    Sub-genera, 2.
76. Python, *Daud.*

c Colubrina.

77. Erpeton, *Lacep.*
78. Scytale, *Merr.*
79. Coluber, *L.*
    Sub-genera, 13.

d Acrochordina.

80. Acrochordus, *Hornstedt.*

SECOND SUB-FAMILY.

HYDRIDÆ.

a Bungarina.

81. Bungarus, *Daud.*
82. Ophis, *Wagler.*

b Hydrina.

83. Hydrophis, *Daud.*
    Sub-genera, 4.
84. Disteria, *Lacep.*
85. Aipysurus, *Lacep.*

THIRD SUB-FAMILY.

VIPERIDÆ.

a Viperina.

86. Vipera, *Daud.*
    Sub-genera, 4.
87. Sepedon, *Merr.*
88. Naja, *Laur.*
89. Elaps, *Schw.*
    Sub-genera, 2.
90. Platurus, *Latr.*

91. Trimeresurus, *Lacep.*
92. Oplocephalus, *Cuv.*
93. Acanthophis, *Daud.*
94. Echis, *Merr.*
95. Langaha, *Brug.*

b Crotalina.

96. Trigonocephalus, *Oppel.*
Sub-genera, 4.
97. Crotalus, *L.*
Sub-genera, 2.

Eighth Family.
CŒCILIDÆ.

98. Cœcilia, *L.*

Second Sub-Class.
AMPHIBIA.

Order IV.
ANOURA.

99. Hyla, *Laur.*
Sub-genera, 4.
100. Rana, *L.*
101. Megophrys, *Kuhl.*
102. Ceratophrys, *Boie.*
Sub-genera, 2.
103. Dactylethra, *Cuv.*
104. Breviceps, *Merr.*
105. Bombinator, *Merr.*
106. Pipa, *Lauren.*
107. Bufo, *Lauren.*
108. Rhinellus, *Fitz.*
Sub-genera, 3.

Tenth Family.
URODELA.

109. Salamandra, *Lauren.*
Sub-genera, 3.
110. Triton, *Lauren.*

Order V.
NULLIBRANCHIA.

Eleventh Family.
AMPHIUMIDÆ.

111. Protonopsis, *Barton.*
112. Amphiuma, *Garden.*

Twelfth Family.
SIRENIDÆ

a Proteina.

113. Axolot, *Cuv.*
114. Proteus, *Laur.*
115. Necturus, *Rafinesque.*

b Sirenina.

116. Siren, *L.*
Sub-genera, 2.

RESEDA. A genus of thalamiflorous plants, nearly allied to the Cruciferæ, but differing from them in the stamens being indefinite, the capsules unilocular, and the seeds without an umbilical cord; and it constitutes an order of its own under the name of Resedaceæ. One species grows wild in Britain; and upwards of 20 species have been introduced from Continental Europe, Africa, and the Levant. But only two species possess any considerable interest; and these are noticed in the articles Dyer's Weed and Mignonette.

RESERVOIR. A contrivance for accumulating and retaining meagre supplies of water. The chief kinds of it required for agricultural purposes are the pond and the dam. See the articles Pond and Embankment.

RESIN. A vegetable substance, which exudes from many trees, either from natural fissures or artificial wounds. Common resin, or rosin, is obtained by distilling the exuded matter of some species of pine; oil of turpentine passes over, and the resin remains behind. The resins are insoluble in water, but soluble in alcohol, and inodorous, though they sometimes derive odour from containing an essential oil. They consist chiefly of carbon, with about one quarter of oxygen and hydrogen.

RESP. See Red Water.

RESPIRATION. The alternate inspiration and expiration of atmospheric air, for the purpose of bringing it into contact with the blood, and exchanging the hydrogen and carbon with which it is charged, for oxygen. This function is therefore closely connected with that of the circulation of the blood. The organs and mechanism by which this wonderful function is carried on, vary considerably in the different classes of animals. In the mammalia, birds and reptiles, the organ of respiration is the lungs; in fish, the gills; in most insects, the tracheæ; and in the lower classes of animals, different parts of the system. The air, being brought into contact with the blood, is decomposed, its oxygen is united with the blood, and its nitrogen is returned by expiration, unchanged, with an addition quantity of carbonic acid gas. A part of the oxygen of the inhaled air is united in the lungs with the free hydrogen, and forms water, which is emitted in the form of vapour, visible at 40° Fahr. Another part of the oxygen unites with the superfluous carbon in the blood, and forms the carbonic acid gas, which passes off with the watery vapour. It is evident from observation, that oxygen gas is necessary to animal life. As to its manner of operating in the body after inspiration, opinions differ. Upon respiration depends also animal heat, which is greater, at least in the mammalia and in birds, than that of the surrounding element. The mechanical part of the function of respiration is effected by the action of the ribs and diaphragm. In the natural state, the ribs are inclined downwards, and when this series of moveable hoops is raised by the action of the muscles, the cavity of the chest is enlarged. The descent of the diaphragm by its contraction increases this effect, and the air therefore rushes in to fill up the vacant space; the ribs then descend, and the diaphragm rises, and the air is necessarily driven out in consequence of the resulting contraction of the chest. About twenty respirations take place in a minute, and from thirty to forty cubic inches of air are inhaled at each inspiration. A man consumes about a gallon of air in the same time.

RESTHARROW,—botanically *Ononis.* A diversified genus of plants, of the lotus division and genista subdivision of the leguminous order. One species grows wild in Britain; about 60 species have been introduced from other countries; and about 50 other species are known. About one half of the introduced species have yellow flowers; and most of the others have either pink or purple flowers. Some are evergreen undershrubs; some are annuals; a few are creepers; and a few are radical herbaceous perennials.

Some have simple leaves, and others trifoliate leaves; some axillary flowers, and others sessile or subsessile flowers; and most have a height of between 6 and 24 inches. Some are said to be grateful to asses, and hence got the name of ononis or "ass-delighting;" and about one-third or so are more or less ornamental.

The cammock, or spring restharrow, or field restharrow, *Ononis spinosa*, or *Ononis arvensis*, is a perennial-rooted indigen of sea-shores and fields and other situations in Britain. Its root is strong, and resists the action of the harrow's tines, and hence gave rise to the popular name restharrow; its stems are hairy, somewhat woody, and commonly about 12 inches high,—yet are very various in length; its leaves are generally simple and entire towards their base; and its flowers are mostly solitary, large, handsome, and of a bright flesh colour, and bloom from June till August. A variety of it, found in a wild state, has white flowers.

The shrubby restharrow, *Ononis fruticosa*, is a native of the south of France, and was introduced to Britain in the latter part of the 17th century, and has long been well known in British shrubberies and gardens. It is a hardy, handsome, evergreen shrub, of about 2 or 3 feet in height. Its branches are numerous and slender, and have a purplish brown bark; its leaves are trifoliate, and come out irregularly on the branches, and sit close, and are narrow, lanceolate, and serrated; and its flowers come out in panicles from the ends of the branches,—and stand on long footstalks, generally three on one,—and are large and pinkish red,—and bloom in May and June; and its pods are short and turgid, and ripen their seeds in July or August.

RESTIO. A genus of monocotyledonous plants, constituting the type of the natural order Restiaceæ. This order is nearly allied to the sedges and the rushes; and consists of rigid, weedy, coarsely grassy looking plants, many of them leafless; and occurs only in the southern hemisphere, and principally in Australia and Southern Africa. Four or five hardy species, 3 or 4 stove species, and nearly 30 greenhouse ones have been introduced to the botanical collections of Britain; and about one-third of the last,—chiefly about 3 feet high, some with simple culms, and some with branched culms,—belong to the genus restio; but all are more curious than either beautiful or useful; though some of the Cape-of-Good-Hope ones are used in their native country for making cordage, and thence occasion the genus to be sometimes popularly called rope-grass.

RESTIVENESS. A well-known, most annoying, and very dangerous vice in some horses. It may sometimes be modified by particular treatment, or restrained by peculiar circumstances, or temporarily subdued by smart and dexterous discipline; but scarcely ever or at all can it be conquered or even permanently alleviated. "It is a rule that admits of very few exceptions," remarks Youatt, "that he neither displays his wisdom nor consults his safety who attempts to conquer a restive horse."

REVOLVING HARROW. See Grubber.

REY-GRASS. See Rye-Grass.

RHABDOCHLOA. A genus of exotic grasses, of the chloris tribe. Three species—all annual, about a foot high, naturally blooming in July and August, very handsome in appearance, and capable of being grown in the open ground, in any ordinary soil,—have been introduced to British collections from the West Indies and North America.

RHAMNUS. See Buckthorn.

RHAPONTICA. A genus of ornamental, hardy, perennial-rooted, purple-flowered, herbaceous plants, of the thistle division of the composite order. Three species, varying in height from 1½ to 3 feet, and all blooming in July and August, and thriving well in any ordinary soil, and nearly allied to the centauries, have been introduced to Britain.

RHEUM. See Rhubarb.

RHEUMATISM. Inflammation of the cellular coat of the muscles, or of the ligaments and synovial membranes of the joints. It was formerly supposed to arise from a defluction of humours to the joints; and it thence acquired its name of rheumatism,—from a word signifying a fluxion or humour.

Rheumatism in the horse is denied by some veterinarians, and was not long ago denied by almost all, yet is really very common. It arises from exposure to cold and rain, especially after being heated with exercise,—from washing the limbs with cold water when they are heated and perspiring,—and, in general, from most of the causes which induce catarrh and influenza; and it most readily attacks young horses who are severely worked, and old ones who have lived a life of coarse treatment or of hard labour. It is sometimes indicated by swelling and perceptible tenderness; but, in general, it shows itself by mere lameness, accompanied always with expression of acute pain, and sometimes with a considerable degree of feverishness. Whenever lameness, after a careful examination, cannot be accounted for, or is found to go off after exercise and to return again, it may pretty certainly be pronounced rheumatic. It is, in all cases, distressing,—in many, obstinate,—in some, a kind of torturing palsy,—and, in most, capable of great alleviation, and even of a real and permanent cure. The remedies for it are bleeding, moderate purgings, fomentations, stimulating embrocations, and somewhat warm and uniform temperature.

Rheumatism in cattle is much more frequent than in horses; and arises from the same causes as in man, or from the same which produce common colds; and is particularly prevalent in cold, marshy, bleak situations, and during great and

sudden changes of weather in spring and autumn; and is in some instances acute, and in others chronic,—in some continuous and accompanied with fever, and in others occasional or fitful and indicated chiefly by stiffness and lameness and expressions of pain. It may generally be palliated, but can rarely be cured. The remedies for it are shelter, warmth, aperients, diaphoretics, stimulating embrocations, and anodyne action both internally along with the aperients and externally along with the embrocations.

Rheumatism in sheep is similar in at once causes, symptoms, and character, to rheumatism in cattle. Any sheep affected with it should be removed to a comfortable shed, and receive a warm aperient, and be rubbed over the affected part with opodeldoc or hartshorn liniment; and, if the disease become chronic, a seton should be inserted near the affected part.

RHEXIA. A genus of ornamental, exotic plants, of the melastoma family. The Maryland species, *R. mariana*, was introduced to Britain from North America about 90 years ago; and is a handsome, hardy, purple-flowered, radical herbaceous perennial of about 9 inches in height; and comprises a variety with pink-coloured flowers. Five or six other species have been introduced.

RHINANTHUS. See Rattle (Yellow).

RHIPSALIS. A genus of exotic plants, of the cactus order. Seven or eight species, mostly about a foot high, have been introduced to British collections, and are propagable from cuttings. See the article Cactus.

RHIZOBOLUS. See Butter-Nut.

RHIZOMA. See Orchis.

RHIZOPHORA. See Mangrove.

RHODANTHE. A recently discovered genus of ornamental plants, of the composite order. Captain Mangles's species, *R. Manglesii*, is one of the handsomest half-hardy annuals at present cultivated in British gardens. It is a native of Australia, and was introduced to Britain about 16 years ago from the Swan River. It has a height of from 10 to 20 inches; and carries a profusion of flowers, with a blending of white and rose and yellow in their colours; and may be made to bloom from early spring till November. A variety of it has semidouble flowers.

RHODIOLA. A small genus of ornamental, hardy, perennial-rooted, herbaceous plants, of the crassulaceous order. The mountain species, *R. rosea*, grows wild in the fissures of mountain rocks and of sea-cliffs in various parts of Britain. Its root is thick and somewhat fleshy, and much divided at the crown; its herbage is smooth, glaucous, succulent, and about 8 inches high; and its flowers are numerous, and have a cymous arrangement, and are yellow in colour with bluish anthers, and bloom from May till July. The root, when recently dried, emits a fragrance similar to that of rose-water; and it thence gives the whole plant the popular name of rose-root.—The Siberian species, *R. sibirica*, was introduced about 20 years ago, and is smaller than our native species.

RHODODENDRON. A genus of ornamental, exotic, chiefly evergreen shrubs, of the rhodora tribe. Nearly 30 species, varying in height from a few inches to about 30 feet, have been introduced to Britain; and a countless number of most magnificent hybrids have been raised by British cultivators. The genus is one of the most splendidly floral of all the ligneous ones in the world; and now rivals the rose genus itself, in both prominence of position and brilliance of effect, in British shrubberies and gardens.

The yellow-flowered or officinal rhododendron, *R. chrysanthum*, is a native of the mountainous parts of Siberia, and was introduced to Britain in 1796. It is one of the smallest of the rhododendrons, and has commonly a height of only between 5 and 10 inches. Its branches are spreading; its bark is brown; its leaves are few, terminal, oblong-ovate, smooth, and stiff, and are rugged and deep green above and ferruginous or glaucous below; its flowers grow in umbels at the ends of the branches, and are large and yellow, and have a monopetalous, five-segmented, outspread corolla, and bloom in June and July; and its capsules are ovate and somewhat angular, and contain numerous, grey, irregular, small, sawdust-like seeds. The leaves of this plant are used in medicine; and have an austere, astringent, bitterish taste; and contain tannin, green wax, and various extractives; and yield their virtues to water by either infusion or decoction; and act upon the animal system stimulatingly, narcotically, and diaphoretically; and are administered to both men and cattle in cases of very bad or obstinate rheumatism; but, when taken in over-dose, produce vomiting, purging, intoxication and delirium.

The rusty-leaved rhododendron, *R. ferrugineum*, is a native of the Alps, Apennines, and other mountains of Continental Europe, and was introduced to Britain about the middle of the last century. It has commonly a height of from 1½ to 3 feet. Its branches are numerous and irregular; its bark has a dark brown colour, tinged with purple; its leaves grow numerously on every twig, and occur in a pleasingly irregular order, and have a lanceolated outline, reflexed edges, and smooth surfaces, and are beautifully green above, and of an iron colour below, and little more than an inch in length; and its flowers come out in round bunches at the ends of the branches, and have funnel-shaped, rose-coloured petals, and bloom from May till July. A variety of this species is more dwarfish than the normal plant, and has white flowers.

The hairy-leaved rhododendron, *R. hirsutum*, is a native of the mountains of Switzerland and Austria, and was introduced to Britain about the middle of the 17th century. It has commonly a height of from 15 to 30 inches. Its branches

are numerous, and have a lightish brown bark; its leaves are plentiful, irregular, and sessile, and have an ovate-lanceolate outline, and are clothed on their edges and under-surface with ferruginous hairs; and its flowers are similar in inflorescence and form to those of the preceding species, and have a light red or scarlet colour, and make a showy appearance, and bloom from May till July. A variety of it has variegated leaves.

The Daurian rhododendron, *R. dauricum*, is a native of Siberia and Chinese Tartary, and was introduced to Britain in 1780. It grows in such profusion and so densely in many of the pine forests of the subalpine districts of central Asia as to make whole tracts appear one sheet of blossom. It differs from almost all the other species, both in being deciduous, and in blooming at an early period in spring. It has commonly a height of about 3 or 4 feet, and is cultivated both in the greenhouse and in the open ground. Its branches are numerous, and have a brown bark; its leaves come out without order on short footstalks, and are broad, naked, smooth, and comparatively small; and its flowers are wheel-shaped and large, and have a beautiful rose colour, and bloom from February or March till May. Its leaves are sometimes used as a substitute for the leaves of the tea-plants. One variety of it has pale green leaves, eventually changing to a brownish tint; and another has dark green or sooty green leaves and purple flowers.

The largest rhododendron, or American mountain laurel, *R. maximum*, is a native of Virginia, and was introduced to Britain in 1736. It has commonly a height of from 6 to 24 feet. Its branches are few and irregular; its leaves come out irregularly on short footstalks, and are large, ovate-lanceolate, and acutely reflexed, and have a shining strong green colour, and present some resemblance to the leaves of the common laurel; its flower-buds form at the ends of the branches, and begin to swell early in autumn, and look turgid and imposing throughout the winter; and its flowers come out in roundish bunches, and are very showy and splendid, and have a pale blush colour within and a peach colour without, and gradually fade away through a series of whitening tints, as they grow old, and bloom from June till August. One variety of it has white flowers; and another variety, or a hybrid, has white and purple flowers.

The Pontic rhododendron, *R. ponticum*, is a native of the East, and of moist shady places near Gibraltar, and was introduced to Britain in 1763. It has commonly a height of from 4 to 15 feet. Its branches deflect without order from the sides of the stem; its leaves stand on short footstalks, and are spear-shaped, acute, and glossy on both surfaces; and its flowers come out in clusters from the ends of the branches, and are bell-shaped and of a fine purple colour, and bloom from May till July. The varieties of this species, which occur in gardens and nurseries, are very numerous,—a few of them imported from Gibraltar, Armenia, and Nepaul, but most raised from seeds or by hybridizement in Britain; and some of the oldest or most remarkable are the white-flowered, the blue-flowered, the rose-flowered, the twisted-petalled, the rubescent, the great-flowered, the double-flowered, the obtuse-leaved, the narrow-leaved, the ovate-leaved, the long-leaved, the silver-leaved, the golden-leaved, the marginate-leaved, the myrtle-leaved, the willow-leaved, the cassine-leaved, the kalmia-leaved, the showy, the beautiful, the azalea-like, and the intermediate.

Some of the most brilliant of the other species are *R. catawbiense*, introduced from North America in 1809, from 3 to 6 feet high, carrying purple flowers from June till August, and comprising varieties of very different colours; *R. arboreum*, introduced from Nepaul in 1820, from 6 to 25 feet high, carrying scarlet flowers in April and May, and comprising many varieties of widely different colours; *R. punctatum*, introduced from North America in 1786, from 3 to 8 feet high, carrying pink flowers from June till August, and chiefly distinguished by its dotted leaves; *R. caucasicum*, introduced from Caucasus in 1803, from 1 to 3 feet high, carrying purple flowers in August, and comprising varieties with rose-coloured, deep red, and straw-coloured flowers; *R. catesbœi*, introduced from North America in 1810, from 3 to 6 feet high, carrying purple flowers in May and June, and comprising red and rosy flowered varieties; and *R. Farrerœ*, introduced from China in 1829, about 3 or 4 feet high, and carrying lilac flowers in February and March. The hybrids which cannot properly be referred to any one species are almost numberless, and, in many instances, rival or excel the finest normal plants or natural varieties in beauty and brilliance.

The rhododendron is often planted among collections of American shrubs, or what are called American gardens, as if it were exclusively or characteristically American; but it figures well and rightfully on all sorts of dressed grounds, and in all kinds of choice shrubberies, and is alike suited to the front of a border, to the expanse of a lawn, to the side of a walk, to unique groups, and to mixed clumps. It prefers a soil of sandy peat, but will thrive amid either a preponderance of sand or an excess of mould. Its power of pleasing resides in the combined effect of habit, foliage, and bloom,—and is so great in the first and the second, irrespectively of the third, as to render it everywhere mighty and beautiful as a mere evergreen; yet both its chief diversity within itself, and its main fascinations during the period of bloom, exist in the varied colours and tints and forms and aggregations of its gorgeous flowers. "The narrow and rather mean-looking leaves of some of the ordinary varieties look poor by the side of the Catawbiense, which is oval and

shining, and of some of the hybrids, which are of considerable size. However, the foliage, though rich among the good sorts, and very noble on well grown, close, bushy, or finely headed plants, is not of much importance among the common varieties. In an ordinary shrubbery many people would seek to plant some of the earliest, and many of the hybrid varieties are as early as March and April; but the disadvantage of these early ones is, the flowers being spoiled by the spring frosts, which is almost always the case; so that, for choice in planting, we should take those which do not bloom before June or the end of May. Nothing is more vexing than to see a perfectly hardy and handsome plant throwing out its still more handsome blooms, and a frost hardly hard enough to whiten the grass of a field, in one night destroying all the flowers that are out. The only diversity worth mentioning among the leaves of the rhododendron is, in the two variegated kinds,—one the gold-edged, the other the silver-edged; these look very well in a border or clump, but the flowers are mean. The best and handsomest of the ordinary kinds are the varieties of *R. catawbiense*, for the foliage is good, the habit fine and close, the flowers varied from white, or nearly so, to dark rose and dark purple, and all the grades between them." Yet almost equal to these for general purposes of decoration, and quite superior to them for particular purposes or in particular situations, are *R. alta-clerense*, a magnificent, crimson-flowered hybrid of 15 feet in height, produced in 1827,—many of the other hybrids which cannot be assigned to species,—and some of the most select varieties of *R. maximum*, *R. arboreum*, and *R. ponticum*.

RHODORA. An ornamental, deciduous, hardy, calyciflorous shrub, of the heath order. It constitutes a genus of itself, and is specifically called *canadense* or the Canadian; yet it forms the type of a large and most imposing tribe, comprising the rhododendrons, the azaleas, the kalmias, the ledums, and five other genera. It is a native of Canada, and was introduced to Britain about 80 years ago. It has commonly a height of about 3 or 4 feet; and it carries purple flowers in April and May.

RHUBARB,—botanically *Rheum*. A genus of hardy, exotic, tap-rooted, medicinal, and culinary plants, of the polygonum family. About 15 species have been introduced to Britain from western and south-western and central and eastern Asia, and from Austria and Bucharia and European Turkey; and they vary in height from 2 or 3 to 10 feet, and, for the most part, carry white or whitish-green flowers in May and June. Five or six are cultivated for sake of the medicinal properties of their roots; and most of these, as well as all the rest, have acidulous, esculent stems, which are used for tarts or in some other and similar culinary way. But the best medicinal roots are obtained from the three species, *R. palmatum*, a native of Bucharia, introduced to Britain in 1763,—*R. undulatum*, a native of China, introduced to Britain in 1734,—and *R. australe*, a native of Nepaul, introduced to Britain in 1823; and the best esculent stems, or rather the only ones which the present state of British horticulture will admit to be tolerable, are produced by British hybrids of comparatively recent origin.

The rhapontic rhubarb, *Rheum rhaponticum*, was introduced to Britain about 127 years before any other species, and became so early and generally diffused, and at the same time became so permanently predominant as to take the name of English rhubarb. A brief notice of this species will convey a sufficient idea of the general appearance of the whole genus. It is a native of the parts of Asia which border on the Black Sea. The root is large and thick, and sends down many subdivisions deep into the ground, and is interiorly yellow and exteriorly of a reddish brown colour. Several leaves, varying in number according to the size and strength of the root, come up foldedly from the root-crown in spring, and afterwards expand themselves; they are smooth, and roundish heart-shaped, and a little waved on their edges, and have a deep green colour, and are traversed from the footstalks to the borders by several strong longitudinal veins, and, on good soil, are often two feet in diameter. The footstalks have a reddish colour, and are a little channelled on their lower side, but flat at the top, and, on strong or even middle-rate plants, are nearly two feet long and thicker than a man's thumb. The flower-stem rises from among the leaves, and has a purple colour, and is garnished at each joint with one sessile leaf, of the same shape as the radical leaves, but comparatively small. The flowers form a thick, close, obtuse spike at the top of the flower-stem, and have a white or greenish white colour, and bloom in May and June, and are succeeded by large triangular brown seeds, which have a border or wing at each angle, and ripen in August.

The red Goliah rhubarb is one of the best of the hybrids for culinary purposes, and as superior to the old harsh, dock-like rhubarbs which were generally prevalent even 10 or 11 years ago as our cultivated celery is superior to the rank weed of the same name which grows by muddy ditches. It is as easily propagated as any other perennial vegetable; and so hardy as to resist the frosts and vicissitudes of our severest seasons; and of all esculents for pies and tarts and puddings, it is the most easily prepared. It is so prolific, too, that half a dozen roots would keep a small family constantly supplied, during 4 months of the year, that is, from the beginning or middle of April, according to the forwardness or backwardness of the season, until the beginning or middle of August; and it is sometimes preferred to all other vegetable substances for the purpose

of pastry, throughout the summer, even where fruits of every kind abound. Stalks of the red Goliah rhubarb have been known to measure 6 inches in circumference and nearly 2 feet in length, so that only one of them was required for a pudding. So delicate and soft, too, is its texture, that as soon as it arrives at the boiling point, it becomes a fine pulp, and is already sufficiently cooked. As a garden production for culinary purposes, it is certainly of much value; being in perfection precisely at that season when apples become tough and scarce, and before gooseberries have made their appearance. Its flavour is so delicate, that it ought not to be mixed with any other ingredient than sugar; and on no account should it ever be peeled. The eyes or buds of the red Goliah rhubarb have a deep rich red colour; its leaves are of different hues of green; and its stalks have a green ground colour, spotted and streaked with red. Its leaves are of enormous size,—sometimes 4 feet long and 3½ wide; its roots also are gigantic,—so large that, in the course of 3 or 4 years, a single root, when dug up, would fill a wheel-barrow; hence, the plants require a wide space,—say 5 feet every way, or 5 feet by 6. Either this hybrid or any other kind of culinary rhubarb may be propagated from seeds, or from young roots of one year's growth, or from clean offsets with each two or three bold eyes. The soil should be rich, and may be prepared in the same way as for asparagus beds. Seeds may be sown either somewhat thickly, with the view of the plantlets being transplanted in a few weeks, or at wide distances and in regular rows, with the view of the plantlets being merely thinned out and allowed to remain permanently when raised. The sowing may be done in September or October, and the final thinning toward the close of the following summer; and intermediate cleanings and hoeings must be given in spring. Roots or offsets may be planted in March, in dry weather, in an open state of the ground, and during a temperate state of the atmosphere. Plants from vigorous roots may be available for use so early as 4 or 6 weeks after planting; but, generally, plants from offsets ought not to lose a stalk or a leaf, except by natural decay, till the following year. When the growth of transplanted rhubarbs or of plants from offsets becomes established, the ground must be kept free from weeds; and if dry weather supervene, water ought to be given freely around the roots two or three times, at intervals of 4 or 5 days. In ordinary culture, nothing farther is done, except to manure the bed in autumn after the leaves have decayed,—and even the waterings in a time of drought are not attended to; but in more refined culture, some special methods are used for promoting luxuriance, succulency, flavour, and blanching. In autumn, the decayed leaves are laid in little trenches, formed along the centre of the spaces between the rows, sprinkled with a handful or two of salt, and covered with the earth that had been dug out; as the winter approaches, a coating of well-decomposed stable-manure or leaves, or a mixture of both, two or three inches deep, is laid round each plant to the extent of two feet; and in the open weather of February, or before the new growth appears, the whole bed is forked over, and a mimic mound, of drift sand, or of light porous earth, or of the soil in the central space between the rows, is formed to the thickness of a foot over each plant, —and this mound must be removed as soon as the season of pulling or of cutting ceases. When the red Goliah is gathered for use, the stalks should never be cut from the bed, but wrenched sideways with a sudden twist, and they will then come away entire from their junction with the root,—round, flat, clear, and as white as milk. As soon as the growth of rhubarbs of two or at most three years old becomes vigorous, the flower-stem begins to ascend from the root-crown of each plant; and this will readily be distinguished from a leaf-stalk, and ought instantly to be pulled away, except from some one plant which is intended to produce seed; and this plant should be less gathered from than others, or not gathered from at all, during the season,— and must not by any means be subjected to the blanching or mound-covering method in spring. The seed should be gathered as soon as ripe; and care must be used that none of it be scattered over the beds; for young plantlets from it might grow up unobserved among the old plants, and greatly rob them of their spreading-room and nourishment.

The foreign rhubarb root of the drug-shops is of two qualities,—the one from Russia and Turkey, containing an excess of tannin, resin, and oxalate of lime,—the other from India or China, containing an excess of extractive matters and gallic acid,—and both, in addition to these principles, containing mucus, alumina, silica, gum, starch, lignin, albumen, and a colouring matter. Good Russian or Turkey rhubarb has a peculiar sub-aromatic odour, and a bitter sub-acid, slightly astringent taste, and breaks with a rough fracture, and is easily pulverized, and affords a bright buff-yellow powder; and Indian or Chinese rhubarb has a stronger odour and more disagreeable taste, and breaks with a smoother fracture, and affords a darker-coloured or more reddish powder. British rhubarb root, also, has been extensively brought into the drug market, and may be grown on any very rich soil of medium texture, and taken up in the third or the fourth year from the time of sowing, and cut into pretty large pieces, and dried either in the sun or in specially constructed kilns; yet it is generally found to be much inferior in quality to the foreign and imported rhubarb root; and it is supposed to owe its inferiority mainly or even entirely to the manner of drying it. "In Tartary," we are told, "the roots are taken up

twice a-year, in spring and in autumn; and after being cleansed and decorticated, and the smaller branches cut off, the body of the root is divided transversely into pieces of a moderate size, which are placed on tables, and turned 3 or 4 times a-day during 5 or 6 days. A hole is then bored through each piece, by which it is hung up to dry, exposed to the air and wind, but sheltered from the sun. In about two months, the roots have lost seven parts in eight of their weight, and are fit for the market." But a variety of ways has been recommended as most suitable in Britain; and some of the chief of these are discussed in seven articles by different writers in the first volume of the Bath Papers.—Rhubarb root is medicinally used in powder, in infusion, in tincture, in extract, and in various solid and liquid combinations; and it acts on man as a tonic and an aperient, and is useful in dyspepsy, hypochondriasis, and relaxation of the bowels; but, in cattle medicine, it is of small service, and acts only or chiefly as a stomachic. The colouring principle of it is of some service in some of the arts.

RHUS. See Sumach.

RHYNCHOSIA. A diversified genus of exotic plants, of the kidney-bean division of the leguminous order. About 20 species have been introduced to British gardens; two or three of them hardy, but the majority tropical; two or three annuals, and the rest perennials; two or three erect, and the rest climbers or twiners; some ligneous and some herbaceous; two or three with simple leaves, and the rest with trifoliate leaves; three or four with white or brown or purple flowers, and the rest with yellow flowers; four or five ornamental or handsome, and the rest possessing little or no beauty; four or five from 5 to 8 feet high, and the rest from 1½ to about 4½ feet high. Fully one half of the species are assigned by some botanists to the genus glycine, and three or four of the others to the genus dolichos. See the articles Glycine and Dolichos.

RHYNCHOSPORA. A genus of sedgy or coarsely grassy plants, of the cyperaceous order. The name signifies 'beaked seed,' and is descriptive. Two British species, the white-headed and the brown-headed, both about a foot high, and blooming in autumn, occur in bogs; and nearly 40 foreign species are known.

RIBBING. A slim method of half ploughing stubble-land. It consists in throwing up the land, after harvest, into a kind of one-bout ridgelets or drills, leaving a slip of fast soil unploughed between every two drills, and covered up by the two ploughed plots. It is nearly the same thing on stubble land as raftering is on grass land. See the article Raftering. It is practised on all sorts of soils, but chiefly when they are in a very foul state, and are intended next year for barley; but it is condemned, in all circumstances, by the majority of good practical farmers, as slovenly, unfarmer-like, and eventually wasteful; and it has been abandoned in many districts where it once was common, and is now rarely practised in any but remote or backward districts. It is usually done with the small one-horse plough.

A species of drilling in spring, with the small plough, is also called ribbing; and this is sometimes found to be peculiarly suitable on soils of a soft friable texture, and also on clays which have been long ploughed, and on naturally soft soils of any kind which have become so smooth as to seem incapable of affording sufficient cover for the seed in the ordinary way by the harrow. A particular implement, somewhat in the form of the old, heavy, quadrangular grubber, has been recommended for doing this kind of work; but a common grubber can at any time be converted into an efficient and economical ribbing-machine, by changing its common tines for a set carrying each a pair of small mould-boards.

RIBES. A genus of calyciflorous, deciduous shrubs, constituting the natural order Grossulariaceæ. This order is nearly allied to the cacti family, but may readily be distinguished from them by the woodiness and leafiness of its stems and by the definite number of its stamens. Seven species of it grow wild in Britain; upwards of 30 have been introduced from other countries,—principally North America and Continental Europe; and a number more are known. Three of the introduced species are procumbent or trailing plants; and all the other introduced species, as well as all the indigenous ones, are upright shrubs, nearly all hardy, and the great majority from 3 to 6 feet high. One group or subgenus are represented by our common gooseberry plant, and, with one exception, have greenish-white flowers; another group are represented by our common red currant,—and some of these have naturally red fruit and others black fruit; a third group are intermediate between gooseberries and currants, and produce their fruit in bunches somewhat similar to those of grapes; and a fourth group are unarmed shrubs, and have yellow, tubular calyxes and many-flowered racemes. The rough gooseberry, the smooth gooseberry, the red currant, and the black currant, in their many cultivated varieties, are universally known as the most common fruit-shrubs of Britain; several other species produce fruit not greatly inferior to that of the red currant; and the majority of the rest produce tolerable, watery, sweet, acid berries. Many, also, are very ornamental, and some make a prominent figure among the most exquisite beauties of the shrubbery.

The two gooseberry species, the red currant, and the black currant, grow wild in respectively the hedges, the river banks, and the moist hedge-banks of some parts of Britain; and they will be found sufficiently noticed in our articles Gooseberry and Currants. Yet we may remark here

that, among the varieties of the red currant, are to be reckoned the white-berried, the striped-berried, and the flesh-coloured-berried,—that among those of the black currant are to be reckoned the green-berried and the yellow-berried,—and that the berries of the black currant possess tonic and stimulant properties, while the leaves of it are glandular and secrete a rich fragrant aroma, remotely similar to that of tea but very much stronger.—The alpine currant, *Ribes alpinum*, grows wild in the woods of Britain, and has green flowers and an ordinary height of about 3 feet, but comprises both a smaller variety and a larger one,—the latter a garden plant with variegated leaves.—The rock currant, *Ribes petræum*, grows wild on the mountains of some parts of England, and has reddish flowers, and an ordinary height of about 4 feet.—The spiked-flowered currant, *Ribes spicatum*, inhabits the moist woods of some parts of England, and is about as tall as the preceding, and has green flowers.

The flowering currant, or bloody-coloured flowered currant, *Ribes sanguineum*, was introduced to Britain from North America only 22 years ago, and is already an universal beauty of shrubberies, and even a very common one of small cottage plots. It commonly attains a height of about 6 feet, and blooms in April and May, and has naturally deep red or blood-coloured flowers; and it comprises many seedling varieties, differing from one another in the colour of their flowers, from the brightest pink to the bloodiest crimson, and from either of these, through all the lighter shades, up to almost pure white. Four old and principal varieties are *R. s. atro-rubens*, with dark red flowers,—*R. s. malvaceum*, with dark pink flowers,—*R. s. glutinosum*, with pale pink flowers,—and *R. s. alba*, with white flowers. But a double-flowered variety, *R. s. flore-pleno*, which was raised a few years ago in the Earl of Selkirk's garden at Kirkcudbright, greatly excels all the old varieties,—coming three weeks later into bloom, so as to escape the spring frosts, continuing longer in bloom, and, not only having double flowers, but producing them in gorgeous pendulous racemes of from 3 to 6 inches in length. The flowering currant, in all its varieties, is one of the most rapid-growing and unfastidious of garden shrubs, thriving well in any common soil, and readily propagable from either layers or cuttings.

RIBGRASS. See PLANTAIN.

RICE,—botanically *Oryza*. A small genus of exotic, annual, cereal grasses, with a panicled inflorescence similar to that of the millets, the bents, and the canary-grasses. It has six stamens, two styles, two one-flowered glumes, and two persistent and equal paleæ.

Rice is indigenous in many parts of both Asia and Africa; and it is cultivated in all the warmer regions of the Old World, in many of the southern parts of Europe, and in not a few places of North America, but especially Carolina. It was cultivated in the East at periods beyond all record; it was long ago introduced to the countries immediately north of the Mediterranean,—Turkey, Greece, Italy, and Spain; it was more recently introduced to Hungary and Central Europe; and it first found its way into the Western hemisphere about the beginning of the last century. Attempts have been made since 1821 to cultivate it in England, Holland, France, Switzerland, Westphalia, and Central Russia,—and these have been particularly directed to the mountain species of it, which is hardier and has much shorter and more rounded grains than the other kinds, and thrives on dry ground while they thrive only on marshy or irrigated lands; but, for all practical purposes, these attempts have entirely failed in England, and have nowhere sufficiently succeeded on the Continent to warrant the hope of ever raising a produce which shall compete in the market with rice imported from Carolina or Bengal. Yet an account of rice-cultivation in the East must be interesting to British farmers and gardeners, not simply as a matter of curiosity, but for the hints which it suggests toward the improved management of all British field plants which love much heat and moisture.

Mr. Porter's definition of rice, in his Tropical Agriculturist, is at once so succinct and correct, that we cannot do better than quote his words. "Rice," he says, "is an annual plant, rising with a round jointed stalk, similar to that of wheat, but the joints are more numerous; its height varies from one to six feet, according to the variety. The leaves are subulate, linear, and reflex; embracing the stalk—they are not unlike those of the leek. The flowers are in a terminating panicle, and are succeeded by single oblong seeds, borne on separate pedicles, which spring from the main stalk of the panicle or ear. The grains are enveloped in rough yellow husks, and from each proceeds an awn or beard; within the husk is a thin pellicle. The whole of the ear more nearly resembles that of oats than any other of the grain-bearing plants grown in England. These seeds, divested of their husk and pellicle, are the rice of commerce. Before they are husked they are called *Paddy;* or more correctly *Paddie*." It were an endless and a useless task to attempt an enumeration of the varieties of rice in cultivation. Heyne enumerates no less than twenty-three kinds, each having a peculiar name and character, grown in the Mysore alone; and Baboo Radhakant Deb, has recently given twenty different varieties of cultivation in as many different districts. The whole, however, may be classed as varieties only of the four great heads, the *Oryza sativa*, or common rice, which thrives only on marshy soils,—the *Oryza præcox*, which also delights in humid situations,—the mountain rice or *Oryza mutica*, which is cultivated in Cochin China, and in Java, and which has its most congenial situation on the slopes of hills,—and the *Oryza glutinosa* or clammy rice, which is an intermediate variety between the mountain rice and the other two kinds, ripening sooner than some, and later than others, and growing alike on wet and dry soils. The periods of maturation of course depend not only on the subvarieties of the plant, but on the soil and climate, and hence the common rice takes according to circumstances from three to even seven months

before being properly ripened. Four and a-half months may be considered as the average time, and two crops are expected annually. The rice in its wild state sows itself in the early winter months, vegetates during the season of the early rains, ripens during that season, and again drops its seed at the approach of wintry weather.

A level surface is essentially necessary for the cultivation of rice, as frequent inundations must be had recourse to. Where this is not the case, the ground is divided into terraces; and to irrigate these, great pains are taken to conduct the waters of the neighbouring springs and rivulets. When the descent is steep, these terraces are often not more than two or three feet wide. In May the preparation of the rice fields commences; frequent ploughing is had recourse to, where that is practicable; but where it is terraced, only the hand-hoe can be used. Whenever circumstances permit, the ground is previously manured, the produce being thereby rendered not only greater, but of superior quality. The seed is sown in a corner of the field, and the plants remain there, till about a foot high. When the soil has been irrigated sufficiently, so that it can be reduced to mud by the hoe, the time of transplantation begins, and this is generally about the middle of June. The seedlings are then carefully plucked up by the roots and planted out, the field being subsequently laid under three inches of water—which after being allowed to stand for a few days is again drained off, and a fresh inundation resorted to. For accomplishing this transplantation only the finger is used, with which a hole is made, for the reception of the seedling. Vegetation then proceeds rapidly. In Behar such is the prodigal richness of nature, that in two months from planting the rice is ready for the sickle. In August a second crop succeeds, and is reaped in November. "Planting a rice field," says Mr. Porter, "is in India a period of jollity and bustle, and the usually inactive Hindoo then displays an alertness and vivacity, which for a while overcomes the phlegmatic indolence of the race." Mr. Tennant in his Indian Recreations, bears also concurrent testimony to the same fact. "This is the grand season of business," he observes, "with the Hindoo farmer, when his concerns absorb those of every other man in the community. He has then a prescriptive right, established by the practice and usage of some thousand years, to call out not only the artists of the village, but their women and children, to his assistance; though the hurry of business should continue a week or two."

To facilitate the practice of irrigation, so essentially necessary to the successful cultivation of the common rice, the neighbourhood of streams and rivers is generally selected. The only other resources are the construction of artificial tanks, or the drawing of water from wells, a process of great labour. In his Agricultural Survey of Bagulkot and Badamy, Dr. Marshall observes, that the culture of rice from a tank or reservoir is so distinct a process as to call for a separate description. "There are," he says, "three of these tanks in this district, the principal is in the vale of Kendow near Badamy, and occupies about 500 or 600 acres. It maintained its depth of from three to six feet nearly at all seasons, being supplied by perennial springs from the hills which surround it, and nothing short of an absolute failure of rain dries them up. It is closed at its southern end by a mound, but the water is perpetually flowing by three or four channels communicating with its bottom by springs, and what thus escapes is sufficient to inundate a tract of about two miles in length, and one in breadth, which is entirely devoted to the rice culture. The fields are not terraced, but appear to be all on one level; there must, however, be an imperceptible slope, as the water does not ever seem to be absolutely stagnant, but there is always a flow from the tank to the river below. The land is perpetually a plunge of two or three feet deep of mud; in this state it is worked, sown, and weeded, and in this state is the grain reaped. Each man's field is separated from his neighbour's, by an embankment of scarcely more than six inches high, and is divided into a number of little rectangles of four or five yards long, and two or three broad, the banks of which are three or four inches high. Two crops are obtained annually, one sown in August, the other in February; the latter is reckoned considerably the best, as in the other the ripening grain is exposed to cold weather, which is injurious to its filling. The ground has not more than fifteen days respite between the reaping of one crop and the preparation for the next." Where streams are not present, and where tanks are not used, the water for irrigation is sometimes laboriously drawn from wells, by the aid of bullocks, in a manner peculiar to India. In a steep acclivity from the edge of the well, a path is made just sufficient for two bullocks to walk abreast, and this walk is proportioned in length to the depth of the well. A wheel or pulley is placed over the well, fixed to substantial beams of wood; and over the wheel or pulley is placed a rope attached to an iron or leathern bucket, ending at bottom in a conical flexible point. To this another rope is attached and conducted over another pulley, placed considerably below the other. The extremities of both of these ropes being fastened to the bullocks, and the animals made to move in a retrograde direction towards the well, the bucket necessarily descends, and fills itself with water; when they are driven forward again, the bucket of course again ascends to the top. The second rope fastened to the flexible extremity of the bucket, being the shorter of the two, it gradually in ascending becomes tightened, and on reaching the height of the channel, where the water is intended to be discharged, it is thrown over and empties itself. Mr. Hamilton in his statistical survey informs us, that if the bullocks are well broken in, one man is capable of managing the whole, and that an eighth of a ton may be raised at once by this simple, yet curious plan.

The mountain rice is much less expensive in its cultivation, as it requires neither such outlay in preparation of soil nor labour in irrigation. In March the land is well hoed and manured, and this operation is for three or four times repeated weekly, and the clods pulverized by a mallet. After the showers of May, it is again hoed, and the mould still farther broken down and smoothed over. Drills at a span's distance are then made by the finger, directed by a line, four or five seeds being deposited in every span's length. A small sprinkling of mould is then laid over them. In four or five days the young plants make their appearance, and from the middle of June to the middle of August, the weeding of the ground by means of a spade becomes frequently a very necessary operation. In the moister grounds, especially those of Nepaul, when the plants are about two feet high, the ground comes to be infested with slugs, worms, and other vermin,—to destroy which, the farmers turn a number of ducks into the rice-grounds. In the earlier part of September the crop usually ripens, and the harvest is gathered in by the middle of the same month. This is done simply by cutting off the ears, which have the grain beat out of them the day after they are reaped, and thereafter it is dried in the sun.

The cultivation of rice is considered, under most circumstances, to be a very profitable speculation. The rice-crop of Bengal is considered to be generally better than that of any other part of India, and is estimated at 40 bushels per acre. Hamilton estimates the average of Nepaul at only 28 bushels. We

are told by Crawfurd, that in Java an English acre of good land yields annually, besides a green crop, 641 lbs. avoirdupois of clean-grained rice; but, on the lighter soils, where two crops are reaped annually, an acre does not average above 285 lbs. per crop. Even in the rich plains of Lombardy, the average crop per acre is only estimated at 48 bushels per acre; and in the Carnatic, where four crops are raised in one year, two on the same ground, we are told by Mr. Porter, that the first crop produces fifty-fold, the second forty-fold, the third the same, and the fourth between twenty and thirty fold. Rice in Java yields, under favourable circumstances, from twenty-five to thirty-fold; but the produce of the mountain-rice does not exceed half this quantity.

The separation of the grain from the ear is, in most countries where rice is extensively cultivated, performed by means of a hand-flail; no machine having yet been contrived for the successful performance of this operation. As the husk adheres very tenaciously, it is passed through a pair of millstones, so far separated from each other as to remove the husk without crushing the grain; the pellicle being afterwards disengaged by trituration in large mortars. The rice of India is for home-consumption husked dry; but when intended for exportation, it is scalded. Paddy or rice in the husk is now imported into England, in considerable quantities, and a great saving of price is thus made. Not only is there less waste in the transportation, but it is divested of the husk much better by the improved machinery of England than by the rude and simple Indian method. The apparatus for this purpose was invented by Messrs. Lucas and Ewbank, who obtained a patent for its exclusive use in the year 1827.

RICHARDIA. See CALLA.

RICINUS. See PALMA-CHRISTI and CASTOR-OIL.

RICK. A pile of corn, hay, straw, or other field produce, regularly heaped up in the open air, and sheltered by thatch from rain and snow. See the articles STACK, HAYMAKING, and BARN-MANAGEMENT.

RICK-CLOTH. See HAYMAKING.

RICK-YARD. The department of the farm-yard appropriated to ricks and stacks.

RIDDER. An addition made to some varieties of the Scotch swing plough, for clearing away the stubble from the coulter. It is a very simple contrivance; but is not needed in any of the thoroughly good constructions of the plough. See the article PLOUGH.

RIDDLE. A sieve, with a circular rim of wood and a bottom of open mesh-work, for separating large and heavy impurities from grain. It may have either a wire or a wooden bottom; and it is made of different diameters, and with different widths of mesh, to suit different purposes and different grains. See the articles SIEVE and BARN-MANAGEMENT.

RIDGE. The portion of a ploughed field intermediate between two open furrows.

The disposing of fields in ridges is designed to facilitate surface drainage; and may be regarded as indispensable on all retentive soils in a wet climate. But wherever it is not really required for sufficient drainage—as on all lands which are suitable for the action of the turnwrest plough, and on all which are naturally porous enough, or artificially subsoil-drained enough, to effect the rapid absorption and permeation of excess of moisture from prolonged and heavy rains—it must be pronounced exceedingly wasteful and injurious,—occasioning as much loss of land as the furrows occupy, as much loss of soil and manure as the surface-drainage sweeps away, and as much deficiency of crop as arises from unequal distribution of moisture. See the articles DRAINING and PLOUGHING. The very high ridges of some parts of England, too, and the very narrow ones of some parts or even most parts of Ireland, entail some serious additional disadvantages of their own. "In highly elevated ridges," remarks Martin Doyle, "the mould is accumulated to such a depth in the centre that it becomes inert, while the soil on the sides approaching the furrows is gradually more shallow; a very high ridge is also under the inconvenience of having the sunny side more luxuriant, and sooner ripe, than the other side less favoured by the sun, or more exposed to wind. The common Irish, like the Norman farmer, who has often a winding ridge (but only because the side of the field at which he commences happens to be crooked), and always an extremely narrow one, four feet, cannot assign any good reason for his bad practice, when on perfectly dry land, except that from habit he would not know how to plough if he had not his frequent furrows to direct him." Ploughing without any kind of ridges, too, or with a perfectly flat and uniform surface, effects a considerable saving of the labours of tillage, and puts the ground into the most convenient state for the operation of mowing, and is favourable for the conversion of arable land into grass. The best methods of it are with the turnwrest plough,—and in broad level ridges with the common plough, followed by a one-bout filling of the inter-furrow,—and in concentric lines round and round a hill from the circumference to the centre, or from the centre to the circumference. "This mode," remarks Sir John Sinclair, in reference to the last of these methods, "requires little more force than common ploughing; it is likewise an expeditious mode, as there is no occasion for turning, and is economical, as by it every inch of the soil is moved."

Whenever ridges are necessary, they ought to be perfectly straight, and to have such a length, breadth, and direction as will best promote economy and best suit the conditions of the land. A length of about 150 yards is very suitable on fields with much acclivity,—of from 240 to 300 yards on wet soils,—and of from 350 to 400 yards on somewhat dry soils. The proper breadth is a subject of great debate among farmers of different views and different districts; but ought to be as great as will comport with thorough drainage and general convenience, and must, in some degree, be determined by character of soil and climate, and by the mode of culture, whether

drill or broadcast. The direction on any field which has an uniform surface and nearly a dead level, ought simply to coincide with the natural water-fall; but the direction on a decidedly sloping field, and still more on a very uneven or very declivitous one, requires consideration, and must be different in different circumstances, and ought, in every practicable or convenient case, or in all other cases as nearly as possible, to be eastward and westward so as to expose both sides and all parts of every ridge equally to the weather. When ridges are planned on the same level along a sloping field, the working of the plough is awkward, and the surface water is liable to be detained in the furrows; when they are formed straight up and down, the uphill working of the plough is difficult to both the ploughman and the team, and the surface water prodigally washes away soil and manure; when they are formed slopingly to the left from the top of the declivity, the uphill working of the plough is about as difficult as in the preceding case, or sometimes more so; and only when they are formed slopingly to the right from the top of the declivity, are the joint conditions of economy and drainage well fulfilled. "When the ridges are laid in this last manner, the horses have a better footing, and the ground always falls from the plough as it goes upward, without any great exertions on the part of the ploughman or the cattle. By this plan, no part of the soil is forcibly turned against the acclivity; but it is so contrived that, on returning down the hill, the furrows fall freely from the plough, and thus every inch of the soil is perfectly turned over. These diagonal ridges are likewise extremely favourable to the cartages of both produce and manure. If there be soil enough, any ground, however steep, may be cultivated on this principle; and by this mode land may be ploughed which would otherwise be impracticable." See the article PLOUGHING.

RIDGELET. A small ridge.

RIDING. See MANEGE.

RID-PLOUGH. A self-cleaning plough. See the article PLOUGH.

RIGIDELLA. A recently discovered genus of ornamental exotic plants, of the iris order. The flame-coloured species, *R. flammea*, was introduced to Britain about 10 years ago from Mexico. It is a very showy and remarkably interesting plant; and has a similar habit, and requires similar treatment, to the old magnificent *Tigridia pavonia*. Its blossoms are beautiful, and have vivid colours, and both develope and fade with astonishing rapidity; their perianth or coloured portion is curiously convolute at the base, and has contractile nerves, and, after being a short time open, rolls itself up in the manner of a screw; the anthers have a prettily diversified hue; and the flower-stalk is partially pendulous or bent while the blossoms are expanded, but rises into a stiffly erect position as soon as the blossoms fall, and maintains that position till the seeds are matured. This plant may be easily grown in a pot of loamy soil, mixed with a little heath-mould and sand; and the bulbs should be taken up when the leaves have decayed, and be repotted toward the month of November. The heat of a greenhouse or of a cold frame is sufficient.

RIME. See HOAR-FROST.

RINGBONE. A bony excrescence around the pastern-joint of the horse's foot. It is caused by concussion; and is formed by the deposition of bony matter in the room of cartilage or ligament. It exhibits every degree from mere incipient deposition up to total anchylosis; and in its approach to the latter stage, it obliterates the joint, occasions permanent lameness, and becomes incurable. The remedy for it in the earlier stages, is a smart and rapid series of counter-irritation, — comprising sweating blisters and setons, and, in bad cases, the actual cautery.

RING-DOVE. See PIGEON.

RING (FAIRY). See FAIRY RING.

RING-FENCE. A boundary enclosure between two farms. See the articles ENCLOSURE and FENCE.

RIPENESS. The maturation of vegetable growth. It means either the natural maturedness of the seeds or fruits of all sorts of plants, herbaceous and ligneous, annual and perennial,— or the sufficient maturedness of any parts of plants, whether seeds, offsets, tubers, cuttings, or whatever else, for the purposes of reproduction,—or the proper maturedness of agricultural and culinary plants, or parts of plants, whether seeds, stems, herbage, or entire bulk, for the most productive or economical harvesting. Remarks on seeds will be found in the articles SEEDS and AGRICULTURAL SEEDS,—on tubers and bulbs, in the articles POTATO and BULB,—and on cuttings, in the articles CUTTING and ABSORPTION IN PLANTS; and remarks on the indications of ripeness will be found in the respective articles on all the principal field and garden crops,—and particularly in the articles on those whose stage of most economical maturity is extensively misunderstood, such as HAY, FLAX, WHEAT, and POTATO.

The uppermost grain in every ear of a cereal crop, and the undermost pod on every stem of a leguminous, is generally the first ripe; so that, in attempting to ascertain the ripeness of growing seeds, the topmost ones of corn crops and the lowermost ones of pulse crops must be examined. In all early and average seasons, the whole ear of a corn-plant is ripe before the straw; and in some late seasons, the straw is ripe, or at least appears to be so, before the ear. Cereal crops, in general, should be reaped before they are quite ripe, or as nearly as possible at the intermediate point between the stage at which they would shrivel from excessive under-ripeness and that at which they would become chaffy in the grain, or liable to lose their seeds, from too complete

ripeness. Oats is the safest cereal crop for cutting before it becomes properly ripe; and barley is the safest for allowing to stand till it becomes fully ripe. "It is difficult," says a writer in the Q. Journal of Agriculture, "exactly to state the ripeness in which corn should be reaped to avoid the shaking out of grains. As a general rule for practice, it may be recommended to reap the culmiferous crops before the uppermost grain can be shaken out either by the wind or in the act of reaping. When that period arrives must be learned by the state of the straw. It is impossible to derive this knowledge from any written description; it must be acquired in the field from personal observation, and afterwards confirmed by experience. If attention is directed to the acquisition of this experience, it will be acquired as easily as the experience which at present directs us to forbear to reap till a certain prefixed day."

In an Essay, in the Transactions of the Highland Society, on the influence of frost and other varieties of bad weather on the ripening of corn, the late Benjamin Bell, Esq., states, on conclusions from a number of experiments, that barley and oats may suffer much and varied buffeting from the weather in every period of their growth without being destroyed, and will even continue to acquire additional weight though frequently exposed to severe degrees of cold, and even occasionally to frost,—that, in late harvests, unripe corns should not be too hastily cut, from an apprehension of their being killed with frost,—that corns will bear a great deal of dry frost, and yet continue to fill, but are less able to resist the effects of rain and wet snow,—that grain which has partially filled or gone on ripening after frost is very unfit to be used for seed, and, if sown, will either not germinate at all, or produce a weak, meagre, and inferior crop,—that beans, pease, and tares are much more liable to be injured by frost than oats, barley, and wheat,—and that all the herbage plants usually sown in Britain are likewise liable to be injured by frost, and none of them more so than the red or broad-leaved clover.

RIPIDIUM. A small genus of exotic grasses, of the villiflorous tribe. Two hardy, perennial species, both about 2 feet high, and blooming in July and August, have been introduced to Britain from Continental Europe. But they are referred by some botanists to the sugar-cane genus, and by others to the genus andropogon.

RIPPLING. See Flax.

RIVER-FARMER. A person who rents a fresh-water fishery for the sake of its fish.

RIVER-MEADOW. An alluvial meadow, or one of low and level surface lying in the bottom of a valley and along the side of a stream. See the articles Meadow, Alluvium, and Irrigation.

RIVINA. A genus of ornamental, evergreen, tropical shrubs and undershrubs, of the goosefoot family. The dyeing species, *R. tinctoria*, was introduced to Britain about 18 years ago from Caraccas. It has a height of 4 or 5 feet, and carries white flowers in May, and is useful in dyeing, and has been called the rouge plant. Six or seven other species, from 2 to 4 feet high, and chiefly with white or with pink flowers, have been introduced from the West Indies and Brazil.

ROACH,—scientifically *Leuciscus Rutilus*. A British fresh-water fish, of the carp family. It inhabits many of our deep, still rivers, and is gregarious, and breeds profusely in lakes, ponds, and weirs. It has a small head, a round, small leather mouth, and large eyes with a gold circle and red iris. It is deep but thin, and has an elevated back. The scales are large, and easily fall off; the fins are in general red, particularly whilst in perfection; the side line bends much on the middle towards the belly; and the tail is a little forked. The roach is so silly a fish that it has acquired the name of the water sheep, in contradistinction to the carp, who for his subtlety is termed the water fox. The flesh of the roach is very wholesome; and the roe, which is green and boils red, is peculiarly good. This fish spawns in May; and is in prime condition in February and March, and in tolerable condition in the latter part of autumn and through the winter, and is caught with baits of gentles, worms, and pastes.

ROACH-BACKED. See Back.

ROAD. A certain portion of land set apart for the purpose of communication between one place and another. As a right line is the shortest that can be drawn between one point and another, so, of course, all roads should be made as straight as local circumstances will permit, in order that we may move from one place to another, by travelling over the least possible portion of space.

For the advantage of general conveyance, roads should be kept as level as possible; because, notwithstanding that facility is afforded to the conveyance of a load down a hill or slope, still as burthens have to be moved in both directions, the ascent of that same hill will occasion a counteracting inconvenience. These may appear to balance each other, and, as far as animal labour is concerned, they probably do so; but in a civilized and commercial country, time is an element that must always be admitted into the calculation, and it is found that the same space can be passed over in less time upon a level road than upon an uneven and hilly one, consequently the level road must have the preference.

Roads should be as hard as possible, in order that they may not wear into holes or inequalities, because a smooth surface is indispensable to their perfection, consequently if the natural soil over which a road passes is not of a proper quality, it will become necessary to obtain and transport hard materials to place upon it. But the great point to be attended to in the formation and preservation of roads is effective drainage. If water is permitted to remain upon a

road, or even in its ruts, hollows, and inequalities, the best materials will fail, and will be incapable of withstanding a heavy traffic; while very indifferent materials may form a tolerably good road, provided proper precautions are used for keeping them dry. A road should also be kept free from all impediments, such as mounds of earth, trees that may be blown down, large stones, or deep pits; because every road should be kept in such a state that it may be travelled over in the darkest night with as much confidence as in broad day-light. To insure all these objects requires a certain degree of care and watchfulness, and frequently a considerable expenditure of money, and the manner in which these objects may be provided for, will be first considered. Roads are usually divided into three distinct classes, called private roads, public or parish roads, and turnpike roads. Public or parish roads, and turnpike or high-roads, are, in some countries, national or government roads.

Private roads are such as are constructed by private individuals, upon their own estates or farms. In these the soil belongs to the proprietor, and he is alone at the expense of constructing and repairing the roads. He may therefore fix gates and lock them up, or change their direction, or destroy and plough them up whenever he pleases, and the public cannot complain; nor indeed have they any right to use them, except by sufferance. In England, it is necessary to lock up such roads occasionally, and to deny passage through them except by permission, and to keep records of such stoppage; because, if a private road is left open to the public for sixty years, it becomes public property, and the proprietor cannot afterwards close it or even change its direction, especially if it leads to a place of public worship.

Public, or *parish roads*, run through a larger district of country, and generally make communications between one farm and another, or between villages and even large towns, so that these roads are much more extensively used; but, inasmuch as they are seldom in the directions that lead directly through a country, they are not so much used by the general traveller as by those who live in their immediate neighbourhood. Such roads are open to the use of the public generally, without any toll or charge; but as funds are necessary for keeping them in repair, and as they require frequent inspection to see that such repairs are performed, they are entrusted to, and considered as the property of the parish in which they are situated. The parish appoints an officer or surveyor, whose duty it is to frequently examine the roads; to give directions to such labourers as may be necessary for their repair, and to provide and appropriate the necessary materials. The labour, together with the necessary transportation of materials by carts and horses, is provided by the inhabitants of the parish, and in order that it may be evenly and fairly distributed among them, an assessment is made upon every householder, according to the extent of the property he holds in the parish. And as this assessment is made by the inhabitants themselves, there is seldom any dispute as to its equity. According to the property of the inhabitant, or the extent of his use of the road, (if more than ordinary,) he has to furnish a certain number of labourers, horses, and carts, for a certain number of days in each year; and they are liable to be called out when the surveyor has occasion for their services, and the entire portion of that labour being completed at any time, he is not liable to be again called upon in that year. The labour, horse hire, &c., is also estimated in money, so that if it is not convenient to afford the assistance in kind when required, he may compound for it in money, which enables the surveyor to hire other assistance. These cash payments likewise fall upon such inhabitants as, notwithstanding their possession of property, may not have workmen or teams; and who, consequently, could not contribute at all, unless they were allowed to do so in money. When parishes become large and the above operation might prove intricate and troublesome, the labour finding system is wholly abolished, and a general money-rate substituted in its place; so that the surveyor has to hire all his hands and teams, and to purchase or dig his own materials. This is, in general, found to be the most beneficial mode of proceeding; because the surveyor can, in this case, pick out and retain good hands, who become accustomed to their business, and work willingly and cheerfully; and experience fully shows that a few good hands who are accustomed to working on a road will do more good to it in a shorter time than a greater number of unwilling hands not acquainted with the business. By the former plan there must be a succession of strange and uninstructed labourers, who may be said to be unwilling, because country labourers, in general, do not like to be put out of their regular routine of agricultural business, and especially to go to a work that they deem compulsory, and which, in many cases, is to produce a greater benefit to their neighbours than to themselves. Still, however, by the one or other process, parish roads are generally kept in a state of very fair condition.

The next and most important class of roads are those which, in Britain, are called the *high* or *turnpike roads*. These are the great travelling roads which go from the metropolis, in as straight lines as can be obtained, through all the principal towns and villages to the extremities of the country; and likewise from one principal town to another. As these roads are for the accommodation of the general public, it would be unjust that the expense of their maintenance and repairs should fall upon the parishes through which they pass; and, accordingly, these roads are supported solely by tolls, taken from all passengers that use them with cattle or carriages, and they are called *turnpike roads*, because they have gates called *turnpike gates*, and collecting houses placed upon them at certain distances, and the tolls there collected furnish funds for the preservation and repair of the road.

As these roads are of great national importance, they are all established and regulated by acts of the legislature. These acts impose penalties upon all persons obstructing the roads, and limit the maximum amount of tolls to be taken from the public, by which imposition is prevented, and the payment of the tolls is made peremptory; for the collector has the right of retaining a horse or other animal in the event of refusal to pay the toll, until it shall be paid. As foot passengers are not liable to toll, of course no provisions are made respecting them, except that they shall not damage or impede the road in any way. The property and management of these roads is vested in trustees, consisting of a number of the most wealthy, active, and responsible gentry and farmers that live in the vicinity of the road. The length of road confided to any one trust is never very long, and seldom exceeds from 10 to 20 miles in any one direct distance; but all the side or cross-roads that branch out of the principal road, and are subject to tolls under the same act of parliament, are included in the same trust, and each trust acts under a separate and distinct act of its own. A turnpike road, consequently, of several hundred miles in length, would be divided into a great number of separate trusts, the one beginning where the other terminates;

and as the trustees are selected from persons dispersed over the whole extent of the trust road, the certainty of having the whole length under the inspection of interested persons is thus secured, without imposing upon them the trouble of going far from their own homes. Each trust elects a clerk and a treasurer. The clerk is generally a respectable attorney residing in the principal town upon the trust road, and he is the secretary and executive of the trustees, to see all the orders they may issue duly carried into effect, and is in fact the representative of the trustees in the interval of their sessions, but has no power to act otherwise than under the directions of the board, unless such power is specially conferred upon him by them for particular purposes. The act of parliament constituting the trust, usually confers the power of suing and being sued at law, in the name of the trust, upon the clerk for the time being.

The funds are raised by tolls charged upon all horses, carriages, and droves of sheep, oxen, &c,. that use the road. These tolls are limited in their extent, though not always fixed by the acts of parliament that raise the trust; because if the trustees find they can keep the road in good order with a less sum than the maximum tolls will produce, they have the option of lowering the sum, though they have no power of augmenting it without a new act of parliament, which cannot be obtained except on proof that the maximum toll is insufficient to insure comfort and safety to the public. In this way the trustees can at all times make their available income accordant with their necessary expenditure, and they can have no interest in making it larger, because the money raised can in no case be appropriated to any other purpose than the maintenance and repairs of the road in their particular charge. These tolls are collected at gates which stretch across the road, and have a small house for the collector adjoining them, as in this country. In roads of much traffic, these gates, for the sake of expedition, are never closed during the day, and the collector is constantly at his post, but they are shut and locked at night, though the collector is bound to rise and open them at all hours to any one desirous of passing: and he can shut the gate and refuse passage to any one who objects to paying the toll, which, to prevent imposition, is required by law to be painted and set forth in letters at least one inch high, on a board at the side of the gate. In England these tolls are only payable once in a day of twenty-four hours, except in a few instances of bridges; so that having once paid the toll a passenger can go backwards and forwards as many times as he pleases between twelve o'clock on one night and the same hour on the following one. To prevent a repetition of the demand, the collector is bound to give a printed pass ticket, with the name of the gate and a number, letter of the alphabet, or some private mark upon it, to a person on first paying the toll, and the reproduction of this ticket exempts him from further demand that day. The letter or private mark is changed every day, so that the ticket of one day will not pass for another.

The trusts upon all roads, and even upon the same road, are perfectly distinct and separate from each other, and they have no interference; consequently each trust is compelled to raise its own funds, and it does this by having its own toll-gates. Every trust must, therefore, have at least one toll-gate on each of its principal and branch roads; or if the trustees do not think proper to collect the whole sum they are authorized to take, at one spot, they may divide that sum, and receive one part of it at one part of the road and the remainder at another. This accounts for the number of toll-gates met with in Britain,—a circumstance that always strikes travellers from strange countries with surprise. Still the principle is good, for if the number of gates is large, the sum taken at each of them is small in comparison to what it must be to raise a similar sum of money with fewer collectors. No person can travel one of these roads for more than ten or twelve miles, without being called upon to pay a toll for the road he is using, and thus the burthen of keeping those roads in repair becomes very much divided among the whole travelling community.

The heaviest expense incident to the English system of turnpike roads, is the maintenance of the toll-collectors, who must be stationed at the many gates, and the apparent liability that may exist of the trustees being defrauded out of a great part of their revenue by their dishonesty, if they do not account for all the money they may receive, or from their being careless and wanting in vigilance in making their collections. This is met and obviated by the trustees never keeping the collection of the tolls in their own hands, but by farming or letting them out by auction for stated periods, to such collectors as will make the highest bidding; such periods being never shorter than one, or longer than three years. Road trustees are, in some cases, allowed to retain a certain limited fund of reserve out at interest on government security, to provide for alterations, amendments, and improvements, where they are likely to occur. And in the event of requiring a sum of money suddenly for such purposes, the tolls are frequently mortgaged, and are considered a full and efficient security for such loans.

The first principles that should govern the formation of roads, are proximity and facility of passage. The first is attained by making the road of communication as nearly right lined as possible whenever the country it has to pass over is so level as to admit of it; but the right lined direction should not be presevered in, when it is hilly and uneven, since a more circuitous route over a level tract of country is better than the shorter one that is hilly, whenever the elevations and depressions of the soil are so extensive as to become inconvenient to the passenger. The operation of *levelling*, and thereby selecting a good and favourable line, is therefore of the greatest utility and importance in selecting a good line of road.

Another and most important subject to be attended to in the selection of a line of road, is its drainage. Many old roads will be found sunk beneath the general surface of the adjacent land, notwithstanding this is the worst principle of construction, and one which no pains should be spared to avoid. As a general rule, every road should be kept above the soil over which it passes if possible; and, whenever this cannot be effected, its surface should be enough of a hill to cause water to run down it; or, if level, it should have side ditches or water-courses, to carry off rains as speedily as possible. Common observation will convince any one that a road formed of almost any ordinary soil, without gravel or any thing to cover and protect it, will be good, provided it is so elevated and drained, that rain water will not remain upon it; while, on the contrary, a sunk road, or one formed like a wide ditch or shallow canal, will be soft and bad, and will wear

into holes or ruts, even if formed of the very best materials, and the greatest pains should be taken for its preservation. For the same reason, a good road is scarcely ever met with in a thick wood, merely because the foliage shuts off the sun's rays, and by excluding them, and a free circulation of air, prevents that evaporation that would otherwise take place. Perfect drainage must therefore be considered as the great and leading requisite to the existence and maintenance of a good road, and this ought therefore to be the great object of attention to the engineer in the setting out new roads, and the amendment of those that already exist. It may frequently be difficult of attainment, especially in level countries; but we will endeavour to give such directions as seem most likely to assist in attaining this most essential object.

No road should be formed in a hollow or concave form, or even be quite flat upon the surface of its transverse section, but, on the contrary, should be convex or protuberant along its central line. If the centre of a road of 20 feet wide, is made 6 inches higher than its two sides, this will keep the middle dry, by throwing the water to the two sides. This rising or convexity in the centre, is called the *crown of the road*, and as 6 inches is the twentieth part of 10 feet, or the half-width of the road, the crown would be said to rise 1 in 20, and a proportionate elevation should be given to the transverse section of every road, whether it is narrow or wide. Such a convexity will occasion no danger to carriages running upon it, or any inconvenience. If such a road is above the level of the adjacent land, the water may be discharged from its two sides without inconvenience, or it may be conveyed into ditches sunk on the sides of the road and running parallel to it. In level countries, difficulties may arise in getting the water discharged out of these ditches, and they may require to be made very deep in the progress of their fall; still, it seldom happens, but that a vent or discharge of some kind may be discovered in the progress of a few hundred yards; and, should that prove impossible, ponds or reservoirs may be sunk in the lowest pieces of land that can be found, in which the water may sink into the land, or be dissipated in evaporation. A very small fall or descent will be sufficient for road ditches. They should begin at the surface, or have scarcely any perceptible depth at the upper part of the road, and become gradually deeper and wider as they descend; and all the soil dug from such ditches should be thrown on to the road to elevate it, instead of being thrown on the outside of it, as frequently practised.

Whenever it may be necessary to sink deep ditches by the side of a road, they ought always to be separated from it by a foot-path or causeway, raised from nine to twelve inches at least above the road, to prevent accidents to cattle or carriages that might fall into them; the water in this case being conveyed from the road by drains passing through such causeway; and, whenever for the purpose of drainage, it may be necessary to convey water from one side of a road to the other, it should always be carried by a drain or brick culvert running under the road, and in no case be allowed to flow freely over its surface.

A perfectly level road is by no means desirable, on account of its property of retaining water; and, as a very slight slope or inclination in the longitudinal direction will be sufficient to produce a discharge of water to the lowest part, while it will hardly be perceptible in its effect upon the draught of carriages, so it ought always to be obtained. By a judicious selection of line, and setting out of a road, sufficient slope may generally be found on the natural ground; but if that is impossible, it must be produced in the earth-work, that is to say, in the slight cutting or excavation that is always necessary for rendering the surface of the ground smooth and uniform, and fit for the hard materials that have to be laid upon it; and by distributing the soil that should be excavated from one or both sides, for draining ditches. Instead of throwing the soil thus obtained upon that part of the road nearest to where it is produced, it may often have to be conveyed a considerable distance; and, whenever that proves necessary, carting the soil in common or three wheel carts, will be found more expeditious and cheap, than moving it by barrows, notwithstanding that barrows are preferable for short distances. The least slope that a road called level should have, is a yard perpendicular in a mile of length; but, as so slight a slope as this will barely affect the water, two, three, or even four yards in a mile, will be better, and will produce a sensible run or discharge of the water. A greater slope should be avoided if possible; because, when the slope is rapid, the water of hard rains runs with such velocity and force, as to wash away part of the materials that compose the roads or side-banks.

As to the width of roads, no rule has ever been adopted, since they should be made suitable to the kind of traffic expected upon them. As a cart or carriage can pass upon a track 8 feet wide, and 3 feet more allows a foot passenger, or even a horseman to pass, many roads or lanes are found that do not exceed 11 or 12 feet in width; but this is a very bad plan, and one that should constantly be avoided, unless in deep cutting, tunnels, or other positions, in which, from local circumstances, such confined width is rendered necessary. It precludes the possibility of good drainage or repair, and when two carriages meet in opposite directions, is productive of serious inconveniences, even if occasional wider passing places may have been provided. Such narrow roads are only made with a view to economy, but it is economy of a false kind; for, if the wheels of heavily laden carriages are con-

strained, by the narrow limits of the road, to move constantly in the same track, they cannot fail to wear it out, and fill it with deep ruts and inequalities in a short time; and the ruts and holes, by holding water, soften the adjacent parts, and frequently render the whole impassable; while, on the contrary, if width had been allowed, when one track becomes bad, another is adopted. The vehicles, instead of continuing in one straight forward course, change from one track to another, thus traversing the ruts and inequalities obliquely, which has the effect of tending to flatten or fill them up; and thus a road that is wide, and has considerable traffic upon it, in some measure, repairs itself, of which there is abundant evidence in many country places, where the roads are little attended to. No road should, therefore, ever be made less than 24 feet in width for any purpose, and in those that are much frequented, from 30 to 60 feet will not be found too much.

Notwithstanding a perfectly straight line forms the nearest communication between one place and another, and can very frequently be obtained in setting out a road, still, if it continues for miles in succession, it is generally admitted to be irksome to the traveller; and, as a gentle undulation or waving of the line produces very little addition to the length, and adds to the beauty of a road, it may be safely admitted, and will in general be approved. When the necessity occurs of a road changing its direction, it should never do so abruptly, but in the form of a long and gentle curve, such a line being more safe and consistent with rapid travelling, than sudden turns, which ought only to be admitted where one road crosses another, and then sufficient space should be left at the intersection to admit of carriages taking such curved direction; and, in every case a certain distance of the road in advance, should be open to view, to avoid the unexpected meeting of what may be moving in an opposite direction. Guide posts, indicating the place a road leads to, should also be set up at all intersections of roads. They are often disregarded by local inhabitants, as being useless to those who, living in the neighbourhood, know every road, but they are highly useful, and save much time and anxiety to strange travellers. In England the road trustees and parishes are bound, by law, to provide and maintain them as part of the road expenses; and the plan lately adopted for making them is good and convenient. The indices, or pointers, fixed to the top of the post, instead of being made of wood with the place painted upon it, (and which is very apt to be defaced,) is made of cast iron, and consists only of letters about three inches high, attached to the surrounding frame, so that no ground or board is necessary, but the whole is transparent with the exception of the letters, and these being seen against the sky, can be read after it is so dark that no other writing would be visible.

In all great roads, mile stones should be set up to indicate the distances to and from places; and these, of course, are placed at intervals of one mile asunder. Formerly the distances were indicated by posts of wood, painted; but these being subject to rapid decay and obliteration, were replaced by stone posts; which, although durable in themselves, are not so in their inscriptions. They might answer if formed of marble or any good stone for maintaining carving, but in many parts they have been formed of the nearest local stone, to avoid the expense of transportation, and the consequence is that many of them are illegible. Of late years, cast iron has been resorted to, and is found to answer the purpose in a more satisfactory manner than any material previously resorted to. They do not require great strength or weight of metal, and are often fixed upon the face of the old ponderous stone. The casting consists of two flat sides about fifteen inches wide, and about three and a half feet high out of the ground, placed at right angles to each other, and united at the top by a triangular piece that slopes so as to make an angle with the horizon of about 60°. The whole is cast in one piece, and the letters stand out, or are in relief. The large figure on the top is the distance from the metropolis, London, and the two sides present the distance from the nearest post towns in the two directions of the road. Being hollow, they may be attached to a post of stone or wood, or the cast iron may be prolonged sufficiently to be set in the ground. They are painted white, and the letters black, so as to be seen at a distance, and are not only exempt from obliteration, but are cheaper, and, it is believed, better than any previous method of marking the distance upon roads.

In many places roads are unavoidably subject to floods, or freshets, so as to become occasionally covered with water. When this is the case, the proper direction of such road should be indicated by posts placed at convenient distances along their sides, with figures, cut or painted upon them at every foot from their bases, so as not only to guide the traveller in his proper track, but to inform him what depth of water he has to pass through.

Trees and live hedges are, without doubt, pleasing to the eye, and add much to the beauty of a road, but at the same time, they are highly detrimental to it, particularly if placed at the south or sunny side. Hedges, therefore, should be kept low by cutting, and trees ought not to be permitted, particularly if their branches are long and overhang the road. Many advocate the planting of a road side, on account of the pleasant shade produced, which is desirable during the hot season; but if trees are sufficiently large for this purpose in the summer, they will inevitably produce more than an equivalent mischief in

winter or wet seasons, by their retention of water, and dripping upon the road, as well as preventing its becoming dry when the rain has ceased. A good piece of road overshadowed by trees, is a thing of very rare occurrence.

It only remains to speak of the manner of rendering roads hard and durable after they have been set out and formed as before directed, and this can only be accomplished by covering them with hard materials. What these materials will be must in general depend on the locality of the road, and its happening to be in a completely inland country, or one that has the advantage of navigation. There is no doubt but that the hardest flint stones make the best road, and next to them the whin stone, trap and basaltic formations, but they are not procurable in all places, and therefore the best materials that can be obtained in the immediate neighbourhood must be resorted to, and in their selection, hardness and tenacity are the great objects to be regarded. When countries are near navigable rivers or canals, it often proves more economical to transport hard materials from a distance, than to use the softer ones with which a country abounds. No material is more universally distributed over the face of the earth than what is called gravel, and accordingly that is generally used for making roads. Gravel is a general term applied to all stones that have the form of pebbles, whatever their composition may be, therefore it is not admitted as the name or character of any particular stone in mineralogy. The hypothesis usually held respecting pebbles is, that they are fragments of rock broken or separated from the large masses, by decay of parts, or by some great convulsion of nature, and that they have been rounded by having their points and sharp edges worn off by attrition in the sea, from whence they have been deposited, by means of which we have no record, in various parts of the dry land, and frequently at elevations far above the present reach of the sea. These pebbles, therefore, vary much in quality, even in the same parcel of gravel, but they are almost universally hard, because the process they must have undergone to bring them to the form of pebbles would grind the softer materials to a state of powder, producing either sand or common soil; and as flint is the hardest of all common or ordinary stones, so the pebbles of gravel are usually of this material. What may be designated under the general name of *gravel*, is divided into several classes, by names dependent only on the magnitude of the component parts. Thus large rounded pebbles, which are never quite round, but are flattened on their two opposite sides, and which are found abundantly on many sea shores, of a magnitude varying from that of a man's fist to his head, are called *boulders*, and these are picked up separately and reserved for the purpose of paving streets. What is generally understood by gravel has no stones in it larger than the fist, but it has all gradations of smaller ones down to sand. The sort always used, or at any rate preferred for road making, is termed clean, or screened gravel, that is to say, the mixed gravel passed through a screen or sieve composed of very strong iron wires, or rather thin rods of iron placed at from half to three-quarters of an inch asunder. All that will not pass through such a screen is termed screened gravel, and that which does pass through is, by workmen, termed *hoggin*. The first is alone used for road making, and the latter for covering causeways, footpaths, and gravel walks; it consists of a mixture of sand and small pebbles, which bind together and produce a hard, smooth, and compact surface.

The old system of road making, or rather road covering and repairing, as followed in England, and which is still persevered in in many places, was, after having prepared the ground or sole of the road by giving it its proper crown or convexity, slope, water tables, and so on, to cart and spread as much screened gravel, without any previous preparation, as would cover the whole road to a depth of from nine to twelve inches, and then to cover this with a thin coat of hoggin, in order to fill up the interstices, and cause the gravel to bind or become compact. This produced a very rough road at first, but by time and use it would become compact and tolerably smooth. In this way it was left until it needed repair, and that repair consisted in first scraping off all soft mud, and then applying another coat of screened gravel without hoggin, so as to cover the old road to a thickness of two or three inches, spreading it by rakes or shovels, to make the surface as even as possible, and to fill up the old ruts and inequalities, and this was repeated every fall or autumn. This practice was continued until Mr. M'Adam, of Scotland, drew the attention of the public to its waste and impropriety, and introduced his improved system of road making, which he began about the year 1810, and which is now almost universally followed. He was led to the consideration of this subject by observing the effect that took place when a heavy carriage, such as a loaded stage-coach, passed over a newly formed road. The wheels being thin and narrow, cut or sunk into the new gravel to a considerable depth, so as to make the draught enormously heavy, and they were permitted thus to sink in, on account of all the gravel pebbles being hard and round, which allowed them to roll about and displace each other, thus completely counteracting any tendency they might have to bind or unite together into a hard mass. Every vehicle that passed in succession produced a new disturbance or displacement of the materials, to such an extent that it might almost be compared to ploughing up the road; nor did the road begin to assume a good and hard aspect, until by the repeated passage of heavy carriages over the materials they were broken and partly reduced to powder. In the same way when a road was repaired by giving it a new coat of coarse gravel, without disturbing the old surface, the wheels constantly made their way through that new coating down to the old surface, displacing the new gravel, unless it was applied in a very thick and expensive manner, and thus the repairs never availed until the new material was partly worn out, as it was supposed, by becoming broken. In the formation of his system he was guided alone by what he saw going on in nature. If the road did not become hard and good until the stones were irregularly broken by the frequent passage of heavy carriages over them in process of time, why impose the duty of breaking the stones upon the carriages,

when it could be more speedily, effectually, and regularly done in the first instance, by hand labour? Again observing that when a carriage wheel, or even a horse's foot fell upon a large stone that was imperfectly bedded or fixed in its place, such stone would be moved, or perhaps turned over, by which a disturbance of all the smaller stones around it took place, and they became loosened and disturbed, he became satisfied that no large stones should be used. The leading feature in M'Adam's system of road making, therefore, is that no large stone, or stone of a spherical or rounded form, however small, should be introduced into the formation of a road, but that the operation of breaking them should be resorted to in the first instance, before they were used upon the road; thus not only reducing them to small magnitude but likewise producing sharp points and angular edges upon them, in order that they might lock into each other, and nearly, if not quite, destroy their tendency to roll about or give way to pressure; and this has been attended with the happiest result, for a bed of broken stone of much less thickness than the gravel formerly used, is found to consolidate sooner, and to produce a much more durable and compact surface than could be formerly obtained; besides which, the broken stones preserve the form in which they are placed upon the road, while in the old plan the rounded pebbles had a constant tendency to shift from the middle of the road, which is most used, towards the sides, thus requiring the occasional use of the hoe and rake for several weeks, to draw them to their former places.

Another objection to the use of rough or unprepared gravel arises from the various dimensions of its component parts. The small and fine stuff has a tendency to set to the bottom, while the large stones work out to the surface, and occasion inconvenience and irregularity, with great additional wear and tear to wheel carriages, until they are broken down; while in the M'Adam plan, as all the stones are reduced to nearly the same size, this effect cannot take place.

Mr. M'Adam also adopted a new system in the repair of former roads, although one of his principles was that a road should never be permitted to get out of repair, which may be effected for a long period, by care and watchfulness. The method of obtaining this desirable end is by having single cart loads or small heaps of ready broken stone disposed at short distances upon convenient places on the waste ground at the sides of finished roads, or wherever they would be out of the way of passengers, and keeping a single labourer to inspect a certain distance of road, who, with a wheelbarrow and shovel could take the few stones necessary to fill up a cavity or rut as soon as it appeared, from the pile nearest to it, and thus by keeping the whole level, none of those concussions of heavy loads occurred, that are more hurtful to roads than anything else. A road suffers little from a heavy load drawn upon it, provided the surface is smooth and regular; but when ruts or holes occur, the wheel sinks into these with all the increased momentum of the fall, and produces an effect that may be compared to that of a prodigiously heavy hammer falling upon the spot: and thus the hardest materials soon crush and are ground to dust, while no such effect occurs on the road while kept with a smooth and even surface.

Still, however, the materials will wear out and give way in time, so as to require renewal, and whenever this has to be done, broken stone alone is to be resorted to; but instead of placing it upon the old smooth surface, as formerly done, and where a very imperfect incorporation took place between the old and hard surface and the loose new materials, he prepares the former road by picking up its top surface with a short and heavy pickaxe to a depth of at least two inches, so as to render it quite rough, or like a newly formed road in appearance, and upon spreading the new stone to a depth of three or four inches upon it, a complete binding and incorporation takes place in a very short time. To this process he therefore applied the new name of *lifting* a road instead of repairing it, though in fact, the lifting only applies to the raising of the old surface to prepare it for proper incorporation with the new material. The road being repaired, has to be watched as before stated, for a few weeks, to fill up any cavities that may occur, since it is impossible, either in making a new road or repairing an old one, to dispose the materials so equably as to ensure that one part shall not sink more than another; but when once these inequalities have been adjusted, and the whole surface has become uniformly hard and smooth, it may be left with confidence, as deep holes or ruts occur through negligence alone.

It may at first sight appear that the breaking of stones is a tedious and expensive process: so it is in the first instance, but it affords employment to old men and children who might not be otherwise employed, and the expense is amply repaid by the smaller quantity of stone required, and the little repair necessary to the road when once properly made. When first adopted, Mr. M'Adam used an iron ring as a gauge for the size of the stones, and no stone was considered to be broken small enough, unless it would pass through that ring. Now the stones are carted in their rough state to the road side. The labourers sit upon the heap, and selecting a large stone as an anvil, they break the larger ones upon it with a long steel hammer, taking one at a time, and throwing them, as broken, to one side. The work is paid for by the bushel of broken stone, and this being measured in the presence of the surveyor or his overseer, if he meets with any stones that the breaker cannot take between his teeth, the work is considered imperfectly done, and is not paid for until the heap has been gone over again. This is a sufficiently accurate gauge, and operates as a check upon the inattention of the workmen.

After a new road has been formed, or an old one repaired, Mr. M'Adam recommends the use of a very heavy cast iron roller to be drawn by horses over the newly laid stone, to render it more speedily solid and compact than it otherwise would be. But a roller of sufficient weight to do good, is so heavy and expensive that it is not always resorted to. Such a roller ought to be about six feet long by four or five feet in diameter, and full an inch and a half thick of metal, to be effective. And lastly, he insists, (as we have done,) in the absolute necessity of good and perfect drainage for every road; saying that if the substratum of natural soil is not kept dry and hard, we may in vain look for a perfect road, since the best materials will be pushed or driven down, and will be buried in the natural soil if soft, by every passing load, and in their passage downwards they raise and protrude a quantity of that soil, about equal to their own bulk on each side, which disturbs and mixes with the broken stones, and renders them unfit for their office, by destroying the foundation they should rest upon. Indeed, so essential it is to the preservation of a good road that it should be kept dry, that the mud or slush remaining on the surface of roads after continued rain, ought never to be permitted to remain and dry there, but should be scraped off and put in heaps at the sides of the road to dry. This scraping should be performed by wooden hoes, about a yard long, as iron ones draw up the stones and produce irregularity. The road stuff, when so collected and dried, forms the best sand for building mortar, and is in general very good for lining furnaces in which great heat is required, and also forms excellent foot-paths.

The greatest difficulty a road-maker has to contend with is a bad substratum or natural soil. If that is good and hard, and so situated that it can be drained, a good road may always be formed, especially if good gravel or other sufficiently hard material can be found to cover it. In clay countries, where gravel or stone of any kind is scarce, an artificial material may be formed (if wood abounds), by making the clay into balls and burning them until they are nearly vitrified. On the same principle, the slag or refuse from iron and other furnaces, makes an excellent material. In the neighbourhood of collieries, the stony or slaty part of coal is used, and in the south-west part of England many of the roads are formed wholly of hard or stone-chalk. In fact almost any thing, except sand, will make a tolerable road, if kept dry, properly scraped, cleansed and attended to, and the substratum is hard, dry, and absorbent. Hardness alone is not sufficient, for solid and compact rock is a very bad bottom, unless when covered by so thick a stratum of good material, as will prevent the surface water from sinking down to it, or its irregularities from being perceived. Rocky countries are generally very broken and hilly, and owing to the smooth surfaces presented, and the water being unable to penetrate into them, the materials will not adhere and become fixed, but are very liable to be washed away by the floods of rain, so frequent in such places. A sandy substratum is also difficult to conquer, except by such a thickness of gravel or broken stone as will entirely prevent any concussion or vibration that occurs at the top from being transmitted below. Should it take place, the lower stones will sink gradually into the sand, which will rise and mix with the upper stratum, thus making room for that to descend until the whole may be lost or buried. The most effectual method of counteracting this effect is to dig the sand out to about a foot in depth, and to place large and flat stones upon the bottom, so that they may take an extended bearing upon the sand; to fill in with large broken stones, or old brick rubbish, if it can be procured, and to finish with stones broken to the usual size. The worst bottom, however, that has to be contended with, is a bog-swamp or morass, in which the ground is soft and full of water, so as to be incapable of supporting small stones, and from which no drainage of the road-way can be obtained. It frequently happens on inspecting a situation, even like this, that some outlet may be found for draining off the top water of a morass, though, perhaps, only for a foot or two, and yet this will at times render the surface better, though it will generally sink or become lower when the water is drawn away from it. It is, however, advisable to drain it as far as possible, and that done, there is no better way of forming a road-way than by placing fascines (as they are called in the language of military engineering), or bundles of brushwood tied together and disposed regularly by the side of each other in the manner of paving, and then placing a second course above these, laid in the cross or opposite direction; the next, or third course, should be parallel to, and in the same direction as the first. The number of layers or courses of these fascines will, of course, depend on the nature of the place, and the quantity of sinking or depression that will take place when they are loaded with gravel. Should the place be very bad, two or three courses may be laid, and then covered with small poles or young trees, laid across the intended road-way (in the manner practised in America in wet and soft places), when other courses of fascines or faggots should be laid upon them; the only use of the poles being to bind the whole together, and prevent the possibility of one part sinking without another, thus extending the pressure over a considerable quantity of surface. The platform of fascines, being thus formed, should be covered with large and flat stones if they can be procured, and a thin stratum of loam or clay, that is nearly impervious to water, is sometimes laid over them, after which the road is gravelled or covered with stone, in the usual manner. The weight of the road materials will generally cause the fascines to sink in the soft bottom until they disappear, and sometimes even the whole road may sink to such an extent as to become useless; and the only way of recovering it is to repeat the former process until a good and hard road is obtained. This is a very expensive mode of proceeding, and one which, of course, would never be adopted, except when local circumstances render it absolutely necessary; because, in most instances, it would be better, and probably, cheaper to go a few miles round, than to cross directly over a bog or morass. See the article PAVING.

ROAD-SCRAPINGS. The mud raked and shovelled from carriage roads. It varies exceedingly in composition, according to the nature of the stones or gravel or other stuff of which the roads are made, and to the amount of animal excrement which is dropped upon them; but, in every case, it possesses considerable manurial powers, and is a good material for forming composts, particularly to clay lands. See the article COMPOST.

ROAN-TREE. See ASH (MOUNTAIN).

ROARING. A disease in horses, who, in consequence of it, are popularly called roarers. See the article BROKEN-WIND.

ROAST-BEEF PLANT. See IRIS.

ROBIN. See REDBREAST.

ROBINIA. See ACACIA-TREE.

ROCAMBOLE,—botanically *Allium Scorodoprasum*. A hardy, bulbous-rooted, culinary plant, of the garlic genus. It is used in salads, and as a pot-herb, and is sometimes called Spanish garlic, but is milder than common garlic. It was introduced to Britain from Denmark toward the

close of the 16th century. Its root comprises a cluster of cloves or bulbs like garlic; its stem is about 3 feet high, and bears at its top many small cloves which, as well as those of the root, are used for culinary purposes; and its flowers have a light purple colour, and bloom in July. A very small bed of this plant affords a sufficient supply to the largest family. The separated root-cloves may be planted by dibbling in February, March, or April; and they will acquire full growth in July or August.—A taller species of garlic, with pale red flowers, a native of Greece, and introduced thence to Britain, *Allium ophioscorodon*, is also sometimes called rocambole.

ROCCELLA. See Orchil.

ROCHEA. A small genus of ornamental, evergreen, shrubby greenhouse plants, of the crassulaceous order. The sickle-leaved species, *R. falcata*—called by Linnæus *Crassula falcata*—was introduced to Britain about 53 years ago from the Cape of Good Hope. It has a height of about 3 feet, and blooms from June till September. It thrives best in a mixture of loam and peat and sand, and loves a full exposure to the heat and light of the sun's rays.—The perfoliate species, *R. perfoliata*, is taller than the preceding, and comprises two kinds with respectively scarlet and white flowers.

ROCHELLE SALT. The tartrate of soda and potash. It is a pharmaceutical preparation; and occurs in large, regular, hard, transparent, prismatic, six-sided or even ten or twelve-sided crystals; and has a bitterish saline taste; and acts as a mild and cooling cathartic.

ROCKET,—botanically *Hesperis*. A genus of ornamental herbaceous plants, of the cruciferous order. One species grows wild in Britain; nearly 20 have been introduced from other countries; and a few more are known. All the kinds in Britain are hardy; and they vary in height from 6 inches to 4 or 5 feet; and two are annuals, six or seven are perennials, and the rest are biennials.

The matronly rocket, *Hesperis matronalis*, concentrates in itself the chief interest of the genus; and is par excellence the rocket of all sorts of common flower-gardens. It is a native of Italy, and was introduced to Britain toward the close of the 16th century. Its stem is erect, and has a height of from 1½ to nearly 5 feet according to the variety and the culture; its leaves sit close to the stem, and are spear-shaped, pointed, and dentated; and its flowers come out in a loose thyrse on the top of the stem, and have a deep purple colour, and emit a delightfully sweet fragrance, especially in the evening or in cloudy weather, and bloom from May till August. It may be regarded either as a long-lived biennial or as a very short-lived perennial; and, in all its varieties, especially in the finer ones, it is most conveniently and effectively propagated by division of the roots; and the new plants of it are particularly vigorous and handsome when they are raised from roots whose stems have been headed down and prevented from flowering. Its best and most distinct varieties are the white-flowered, the double white-flowered, the double red-flowered, the variegated double-flowered, and the leaf-flowered; and good plants of some of these carry close, dense spikes of flowers, somewhat in the style of prime double-flowered stocks. The matronly rocket is said by Boerhaave to be anti-scorbutic and diaphoretic, and of great service in asthmas, coughs, and convulsions; and it has been recommended also as an external application in cases of cancer, gangrene, inflammation, and contagious diseases; but it does not appear to have really any appreciable medicinal virtue. —The indigenous rocket, *Hesperis inodora*, inhabits the pastures of some parts of Britain; and very much resembles the matronly rocket, and is ranked by Decandolle as merely a variety of it, and has a place by the side of it in some gardens; but its flowers are pink-coloured, and have no fragrance, and do not continue so long in bloom.

ROCKET,—botanically *Eruca*. A small genus of hardy annual plants, of the cruciferous order. The cultivated species, *Eruca sativa*,—called by Linnæus *Brassica eruca*,—is a native of the South of Europe, and was introduced to Britain in the latter part of the 16th century; and it comprises eight or nine varieties, all of which were formerly in some request as salad plants. Its leaves rise numerously from the root-crown, and are spear-shaped and indented and 4 or 5 inches long, and spread on the ground; its flower-stem is solitary, and rises to the height of from 12 to 21 inches; and its flowers grow in loose bunches at the top of the stem, and are white in some varieties, yellow in others, and pale yellow in others, and are succeeded by long two-celled pods, filled with small round seeds. When this plant is used as a salad, it requires to be eaten young, and only in winter or spring; for it is too strong and rank when old or in summer or autumn. Its qualities, in fact, are too biting; and gave rise to the name eruca, from a word signifying to burn; and have eventually brought it into general neglect. It formerly took rank among medicinal plants as a good diuretic.

ROCKET (Cress). See Cress-Rocket.

ROCKET (Sea). See Cakile.

ROCK-ROSE. See Cistus.

RODRIGUEZIA. A genus of ornamental, epiphytous, tropical plants, of the vanda division of the orchidaceous order. The side-flowering species, *R. secunda*, is an elegant, red-flowered, October-blooming plant of a few inches in height, and was introduced to Britain about 30 years ago from South America. The crisped species, *R. crispa*, has singular-looking crisped flowers, of a dull sea-green colour, bordered with yellow, and emitting a fragrance similar to that of the primrose; and was introduced to Britain 10 or 12 years ago from the Organ mountains of Brazil. Several other species have been introduced.

ROELLA. A genus of ornamental Cape-of-Good-Hope plants, of the bellflower family. Six or seven species, chiefly blue-flowered summer-bloomers of about a foot in height, some annual and others perennial, some herbaceous and others ligneous, have been introduced to the gardens of Britain.

ROHAN. An artificial pace of specially-trained riding-horses in Egypt and Turkey. It resembles the amble in easy effect, but differs essentially from it in character, and gives the horse an awkward, straddling, broken-backed appearance. It is produced by so loading the pasterns of the hind legs with metallic discs as to prevent the fetlock-joints from bending, and to cause their office to be peformed by other portions of the limb; and it, in consequence, renders the foot-fall comparatively soft and the seat of the rider comparatively free from concussion; and, when it is fairly formed, the metallic discs are removed.

ROLLER,—scientifically *Coracias*. A genus of birds, of the crow division of passerinæ. The common roller, *C. garrula*, is an occasional visitor of the shores of Britain. It is about the size of the jay, and has a total length of 13 inches. Its general plumage is sea-green and various shades of blue; its back and scapulars are fawn-coloured; the tip of its wing is pure blue; and several parts of its body are tinged with verditer, brown, and black. It is a very wild bird, though sociable enough with its fellows; it is noisy, and builds in the hollows of trees, and migrates in winter; and it feeds on worms, slugs, insects, small frogs, and berries.

ROLLER. An implement for compressing, smoothing, pulverizing, or otherwise finishing-off cultivated land, whether in grass or in tillage, in preparation for sowing or subsequent to sowing, in a newly sown state or after the appearance of the nascent crop. Both the forms and the uses of the roller, in fact, are exceedingly diversified; and some of the most useful implements of the roller class differ so very widely from all the old and common rollers, and at the same time from one another, as to take to themselves peculiar names, such as drill-roller, seam-presser, and clod-crusher.

All the old or early rollers were simply cylinders, and may be supposed to have been employed only for breaking down the cloddy and lumpy portions of tilled stiff soil preparatory to sowing, and for compressing and smoothing and consolidating light and driftable lands immediately subsequent to sowing; and such rollers are still confined to the same principal uses, with the addition of the smoothing and compressing of grass lands. They are thought by some writers to have come into existence coevally with the plough, or with the rudest stirrer of the soil, or at least to have appeared immediately after it,—and certainly they occur in countries where agricultural processes are in a very rude and almost nascent state; yet they are assigned by other writers to an epoch later than the harrow, and even than the grubber,—or to one in which the pressure of increasing population drove farmers by necessity to the cultivation of stubborn and adhesive soils, and compelled them to invent mechanical means for breaking hard clay clods. The cylindrical roller, at all events, is known to have been till recent times the only implement of its class; and though this might seem to a superficial thinker to have been quite simple and unique and incapable of variety, it really received, in the course of time, a great diversity of size and weight and construction, and was made first entirely of wood, then of stone with a wooden frame, and then in various ways of iron, and came at last to be formed of two or three or more parts, revolving either on the same axle or on independent axles.

The common rollers, or land-rollers, of the present day comprise all the varieties which have ever been used, except the most rude and ancient. The wooden ones are either pieces of heavy solid timber, of the full diameter of a large tree, or hollow cylinders, variously constructed, and of comparatively large diameter; and though they make little impression on any but very light soils, they are highly serviceable for levelling potato or turnip drills, for compressing the earth about newly sown seeds, and for some other and analogous light purposes. Some are spiked with iron or encircled with large metallic rings, to assist in crushing clods; many or most have simple contrivances, generally a weight-containing box on the upper part of the frame, for temporarily increasing their weight and pressure; and all are mounted with a skeleton cart-like frame, terminating in shafts for one or two horses, or with attachments for four or even six oxen, according to their respective size and weight. The common solid wooden rollers of England are usually made of oak or ash, and generally vary from 5 to 7½ feet in length, from 16 to 20 inches in diameter, and from 10 to 15 cwt. in weight, but occasionally are 9 feet in length, from 20 to 30 inches in diameter, and so heavy as to require to be drawn by 4 horses or 6 oxen. A very common roller in Scotland 20 or 30 years ago, and one most easily and cheaply procured, had a wooden axle, with two or three rows of spokes placed in it according to its length, and felloes placed on the extremity of the spokes in the manner of a cart-wheel, and planks or boards of wood fastened on the felloes all round; and a closely similar roller, of still more facile construction, is now occasionally made in England, with three broad wheels of the required diameter,—two of them placed at the ends and the other in the middle of the required length,—and with an iron axle passing through the whole, and adjusting them to their positions, and with strong, narrow, bevelled planks nailed firmly lengthwise round all the exterior. Some hollow wooden rollers

have an octagonal instead of a circular circumference; and they do their work better than the circular ones, on account of each turn laying the flat surface with a momentum on the ground; but they require a greater power of draught. Many wooden rollers, also, as well as many stone and many iron ones, are double, or consist of two pieces, placed in one frame, and performing the same action as one piece, but rolling independently of each other; and not only are these much more convenient in turning than single rollers, and less severe on the team, but they are more suitable for light soils or corn crops or sown grass, in consequence of their neither tearing up the ground nor injuring the young plants at the end of a field.

Stone rollers of granite, or of hard, compact, crystalline trap, are very common in districts which abound with these materials, and are both very cheap and very efficient. They are usually made of from 12 to 16 inches in diameter; and, including the cost of both frame and scraper, they are sometimes from 5 to 10 times cheaper than equally efficient wooden ones, or from 8 to 12 times cheaper than equally efficient iron ones. They have the high advantage also of being easily and cheaply obtained of a great diversity of size and weight and mutually proportional length and diameter; so that from 5 to 12 of them of different kinds, in adaptation to different soils or different states of soil or different kinds and conditions of land and crop, may be kept on a farm for the price of a single roller of iron or of wood.

Iron rollers of the common cylindrical kind are the most common for gravel-walks, lawns, parks, and other land-surfaces which require to be kept firm and smooth; and they are also common for ordinary agricultural purposes, in some districts which are destitute of granite or compact trap; and they possess the advantage of admitting a temporary increase of their pressure by means of suspending weights on their axis. They are made of great diversity of size and proportions to suit a corresponding diversity of tastes and purposes; and one of the most approved, for ordinary agricultural uses, is double, or has two separately revolving parts, and weighs from 10 to 15 cwt., and is drawn by two horses; while another has three separate cylinders, each about two feet in diameter, and of the same length. As cast-iron rollers are liable to fracture when drawn along a rough road, in transit from one field to another, a small low-wheeled wooden carriage may be kept for the purpose of transporting them.

Booth's roller was invented by the late George Booth of Allerton, near Liverpool, and comprises five cylindrical pieces, arranged alternately three in one line and two in another, and so constructed on the lever principle that they may be pressed down by weight, and possessing each a diameter of not more than a foot. "Mr. Booth," says Mr. Ransome, "contended for solid rollers of very small diameter, as the most effective in crushing the clods, and throwing the greatest weight on the surface of the ground. From this opinion I venture to differ, believing that whatever advantage may arise from small diameters, it is more than counterbalanced by the difficulty of surmounting clods and other obstacles, and their consequent tendency to drive them before the roller, which would also cause increased labour to the horses."

Spiked rollers are used to reduce the lumps and clods of clay soils. Those of the simplest form consist each of a single wooden cylinder, with spikes of about 3 inches or so in length, inserted quincunxly or in some other regular order; and these perform their work pretty well when the land is dry, but become clogged and inefficient when the land is moist. But the better kinds of spiked rollers have each two cylinders, the one placed before the other, both armed with regular and mutually alternate rows of spikes, and the two adjusted so closely together as to intersect each other's rows of spikes, and in consequence constantly cleanse each other in all their revolutions. One of this class, described in the Leicester Report, has rollers of about 9 inches in diameter, armed with eight rows of spikes, fixed in a frame, mounted on wheels of about $3\frac{1}{2}$ feet in height, and provided with an upright post windlass and power of pullies to raise or lower the rollers at pleasure.

The Earl of Ducie's improved clod-crusher has two parts or lengths in the manner of the common two-cylindered iron roller; but instead of a continuous surface, it has from end to end, round all its circumference, a series of square wrought-iron bars; and it presents the angles of these bars to the clods, so as readily to penetrate and reduce them. It acts well in its proper capacity of a clod-crusher, and at the same time is useful for rolling or pressing wheat in the spring.

Bartlett's cultivator is a roller of 13 thin iron plates of 15 inches in diameter, each fastened to a circular block of wood 4 inches thick, 9 inches in diameter, and bound round with iron,—the plates and the blocks strung together on an iron axle, and made moveable upon it,—and the whole adjusted in roller-style within a strong quadrangular frame, and subtended by a bar with fixed iron scrapers, which keep the roller continually clean. This implement is said to be serviceable in the tillage of wet lands in the extreme south of England; and it may be made with plates and blocks of other sizes than those which we have named, or those adopted by the inventor.

The double-jointed barley-roller is simply a variety of the common two-cylindered or three-cylindered iron roller; but is so constructed that the parts may revolve at opposite angles,—and may also, for convenience in travelling or for any special purpose in tillage, be placed the one behind the other. Its framing, too, is often so con-

structed with twisted joints, as to make the inner end of one part work behind the end of the other, so that no seam is left between them.

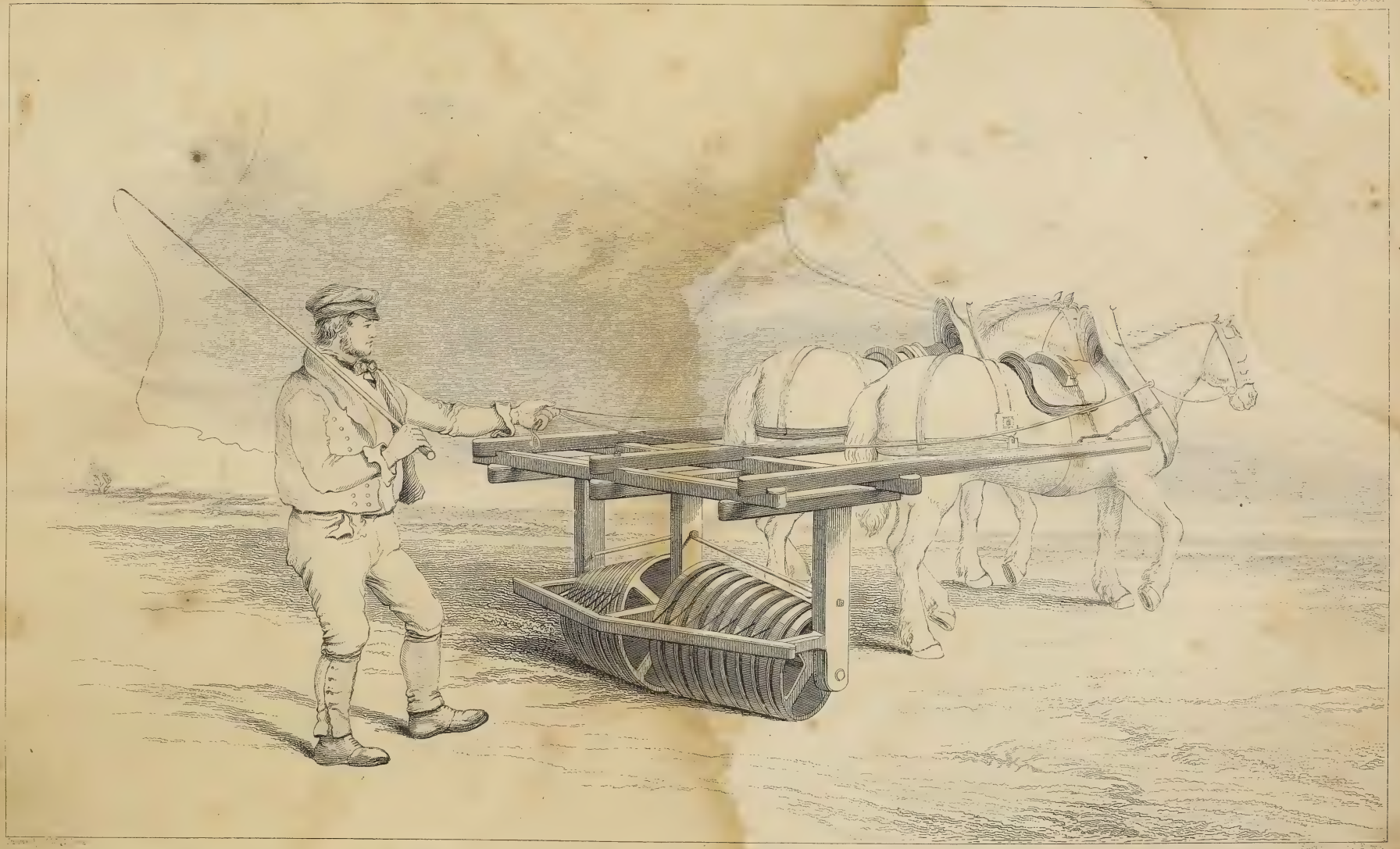
Lord Strathmore's soil-consolidator is a combination of machinery for the purpose of consolidating loose soils. First in it are two common rollers; and these put in motion two wiper shafts; and these lift, in continued rotation, a number of stampers, which are let fall on the soil while the machine is travelling over the surface.

Drill-rollers have a series of stout metallic rings, upon an axis, each commonly about 2½ inches thick, and sometimes so much as 3 feet in diameter; and they are used either without weights for making grooves ready on light soils to receive the seeds of a broadcast sowing, or more or less heavily laden with weights to crush the clods of rough and strong land in the manner of common or of spiked rollers. They have long been known to the farmers of Norfolk and Suffolk, and were a highly appreciated implement so long as 40 years ago; and they have of later years been variously improved,—but principally in rendering each ring independent of the others, so as completely to accommodate their action to diversities of surface, and to facilitate their turning at the end of fields. When a drill-roller is used for crushing clods, it requires to be followed by a harrow of sufficient weight to lighten up the surface; but when it is used for making grooves preparatorily to broadcast sowing, it should not be followed by anything heavier than a fine short-toothed harrow, or even than a mere bush-harrow.

The seam-presser or land-presser or pressure-roller is an abstract of a drill-roller, and has but two double conical wheels for pressing, and is greatly employed in some districts for rolling down the soil newly turned up by the plough, or for closing the furrow-seams of a seed-furrow from lea. The two double conical wheels are set upon an axle, at about 10 inches apart, and are situated on the one side of the machine-frame; while a common wheel supports the other end of the axle, and occupies the corresponding side of the frame. The machine, in working, follows in the wake of two ploughs; its conical wheels run in the seams of the last turned-up furrows; and its common wheel runs upon the unploughed land. It acts more effectually than the drill-roller, and directs its whole force upon each furrow, and gives a firmer bottom for the germination of the seeds, and tends to retard, if it does not altogether prevent, the insidious operations of the wire-worm.

The conical grooved pulverizing land-roller, was invented by J. Stewart Hepburn, Esq., of Colquhalzie in Perthshire; and is described and figured in the 11th volume of the Highland Society's Transactions. It comprises three varieties, and has, as its chief characteristic features, a conically diminishing instead of a cylindrical form of roller, and a series of transverse parallel flutings round the roller's surface. Two of the rollers or conical frusta are adjusted in one frame, base to base, and have their axes so inclined that both the fore-part of their peripheries and the parts in contact with the ground are always in a straight line. The frame is the same as that of a common roller; and three perpendicular bars from it carry the axes of the two rollers; and a light horizontal frame with scrapers is adjusted behind the rollers to clear the grooves of the rollers when at work from all adhering soil. "The effects of such a form of roller upon the surface of the soil," remarks Mr. Slight, "are peculiar and important. While the cylindrical smooth roller acts merely by its pressure on the rough soil intended to be pulverized, one of a conical form, arranged in the manner of Mr. Hepburn's, will, besides acting by its direct pressure, produce a strictly pulverizing effect, by reason of its form; for the cones having a constant tendency to move outward in a circle, but being restrained by the bearings in which they revolve, their surface will produce a crushing and abrading action well adapted to the pulverization of the soil." *Plate LI.*

Crosskill's patent clod crusher is, in several respects, a remarkable and very valuable implement, and was pronounced by the judges to be, with its latest improvement, the most beneficial implement used in agriculture exhibited at the Newcastle Meeting of the Royal Agricultural Society in 1846. "Mr. Crosskill," says the official Report of that Meeting by Mr. Parkes, "about the year 1832 imagined the form of this roller. His first plan consisted in forming a barrel, by stringing a number of narrow indented rims or discs loosely upon a square axis, the whole revolving, together with the axis, in the journals of the frame. In addition to the saw-like teeth into which the periphery of each rim was divided, other teeth were formed, projecting sideways from the plane of the rim, and in a radial line from the centre, so as to leave no portion of the soil unoperated upon. This roller gradually fought its way into considerable practice, being found to effect a much greater amount of superficial pulverization than the common plain roller. Extended experience disclosed other uses than mere clod-crushing, to which it was applicable; and at the same time pointed out defects which deteriorated its performance and diminished its value. The rolling of young wheat and spring corn, or other plants, was commenced with it, and usefully; but it was found that, on turning short at the headlands, injury was done by tearing up the soil in the act of turning. A greater scope for turning than is convenient was, therefore, necessary to avoid this evil. Another evil resulted when using it on soils at all damp or sticky, from the adhesion of earth to the teeth and their interstices, which further limited its useful employment. Mr. Crosskill, observing these defects, applied himself to their remedy,



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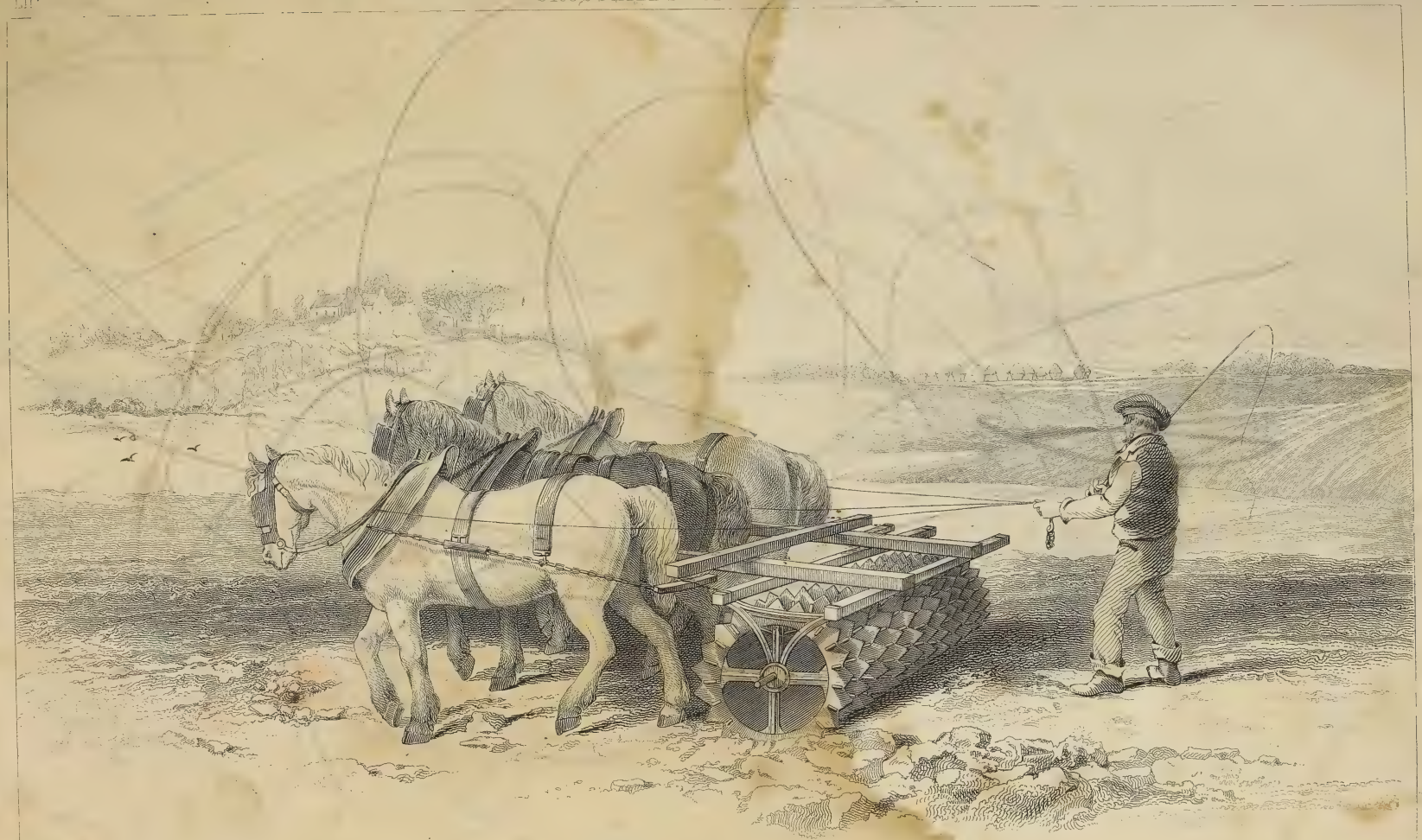

Drawn by J.W.M.C.Lea Engraved by J.J.

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and in 1842 he took out a patent for the present implement, the improvements consisting, first, in setting each toothed rim free to revolve separately on a round, instead of their being fitted on a square axle ; and secondly, in giving a different form and direction to the lateral teeth. By the first-named alteration the independent action of each rim was secured, so that each rim, in the progressive movement of the whole series, revolves upon its axis, and at the rate exactly due to the space to be travelled over in surmounting the irregularities presented to it ; whilst in turning, all tearing of the soil or plants is avoided by the same faculty, which permits every rim or disc to adapt its velocity to the space required for each one to pass over, either forwards or backwards, in the act of turning ; in fact, this roller can be turned about on the centre of its axle without producing any injurious effect. The independent motion of the rims also provided a powerful means of self-cleaning ; for, inasmuch as the velocity of the several rims is perpetually varying, so they rub off the soil which might otherwise adhere to them—an action now further increased by enlarging the bore of the eye of each alternate ring, which causes a kind of eccentric or up and down motion to take place between each pair, and among the whole series of rings or discs. This last improvement consists in the enlargement of the eye of each alternate ring, forming collectively the series of rings or discs of which the roller is composed ; so that of these rings, which are 23 in number, 12 have eyes fitting the axle just freely enough to revolve upon it, whilst the 11 alternate rings have their eyes enlarged about half an inch more in diameter. This arrangement has added materially to the effect of the implement in abrading and reducing hard clods ; it has also induced among the rings a more efficient self-cleaning movement, when the roller is used on moister soils or softer clods ; so that, practically, the scope and power of the roller have been augmented, without adding to its cost, or impairing its extreme simplicity ; and it can now be employed on soil when in states which would have clogged it, or have diminished its effect if all the rings on the axis had eyes of similar size. The superior results arising from this disposition of parts are altogether attributable to what is properly termed action — mechanical action ; and it has been owing to its possessing this function in so high a degree, that Mr. Crosskill's patent-roller has proved to be more effective in comminuting and compressing soil than the common plain roller, or than the serrate-edged ringed-roller with a square axle, first introduced by him. Mr. Crosskill's square-axle toothed roller first made its appearance in the Society's show-yard at Cambridge in 1840—the round axled patented machine at Derby in 1843—a premium of £20 was awarded for it by the judges at Southampton in 1844—and it gained the Society's prize of £10 at Shrewsbury in 1845, having on all occasions of trial at the Society's shows greatly excelled the performance of every other roller brought into competition with it. The fourth volume of the Royal Agricultural Society's Journal contains a large collection of instances of its utility in arresting the ravages of the wire-worm—an effect owing probably to the forcible bite of the teeth on the ground—in the pulverization of stiff, and compression of light soils, together with the opinions of numerous agriculturists upon its value as a roller of various crops in a state of young growth. Its application to the latter purpose has greatly extended since that period, and the writer may bear his testimony to the success attending its employment on pasture land in destroying the white slug, curing mossiness, and especially in consolidating soft grass-land after drainage. For these latter uses the effect of the implement is greatly enhanced by weighting it to the full extent of the power of the team which can be commanded." See the article Rolling.

Garrett's patent clod-crusher and cultivator has also a heavy, rough, biting surfaced cylinder, and comprises a patent improved method of heightening or lowering the wood carriage wheels, so as to produce any required degree of pressure in working, and to obviate all difficulty in removing the implement from field to field. This roller acts very powerfully in crushing clods on heavy lands ; and is peculiarly suitable after a drought, or in a very dried state of the soil, for preparing fallow lands for root crops, and for pulverizing hard and cohesive cloddy surfaces, and raising mould for the barley seed. Some very experienced agriculturists who have tried it recommend it as most desirable for preparing clover lands for wheat, by rolling it once or twice over the ploughed and dried land, in order that it may thoroughly press down the flag, and raise an inch or more of mould on the top ; for when the implement is so set upon the travelling-wheels as to enter the ground to the depth of 1½ or 2 inches, it gives that firmness to the under soil which is so desirable for wheat, and presses down the flag so closely as not to admit any harbour for the slug, and at the same time acts as a preventative of the ravages of the wire-worm.

ROLLING. The employment of the roller on gravel walks, on grass lands, on ploughed lands, on sown lands, or on young or rising field crops. Rollers of different kinds, and different weights and sizes, are required for different purposes ; and those of the garden are few and simple, and of easy and obvious application,—while those of the farm are very diversified, and cannot often be used without much judgment respecting the proper time and the suitable circumstances for applying them.

The heavy smooth rolling of pasture lands is highly beneficial under a variety of conditions,—and particularly when the surface has been ren-

dered uneven by the treading of cattle or by the operations of the mole and the ant. The rough rolling of grass lands with Crosskill's roller or with some other of similar action,—followed, however, by a common smooth roller,—is very serviceable in a mossy state of the surface or after the spreading of compost. The smooth rolling of dry absorbent grass land, at an early hour in the morning, when rain has fallen copiously enough to moisten the surface stratum, but not so copiously as to occasion any poaching from horses' feet, is very advantageous for destroying slugs and insects, and for promoting the general health of the sward. The rolling of meadows immediately after the removal of hay is useful for pressing the shed seeds into the soil, and for thickening the next growth of grass.

The rolling of strong ploughed land, in the course of tillage, or in the process of summer-fallow, reduces the most obdurate clods, and powerfully assists the action of the grubber and the harrows, both in co-operating with them to pulverize the soil, and in enabling them to tear out the roots of couch-grass and other destructive weeds. The rolling of light arable land, preparatorily to sowing, renders it comparatively compact and firm, and enables it to retain moisture and to give a good basis to the roots of growing plants, and may occasion it, in a dry season, to yield a very considerably larger crop than it could possibly produce in its naturally loose state. The rough and heavy rolling of cloddy ground, with Crosskill's roller or some similar implement, at a droughty seed-time, makes sure of a sowing season in even the driest weather, and pulverizes into a fine mould such hard and stubborn surfaces as could not possibly be prepared for the seed by any other known process.

The smooth or common rolling of sown lands and rising crops is beneficial in various circumstances and for various ends;—of any crop of grain sown with artificial grasses, for making an even surface, bruising all clods, and pressing down small stones in order to facilitate the future operation of the scythe;—of oats on a light soil, immediately after the seed is sown, unless the ground be so wet as to clog the roller;—of wheat in the spring, after frosts, in order to make the soil lie more closely to the roots of the plants, to encourage vegetation, to strengthen the stems, and to render the grain more perfect;—of drilled turnips, immediately after sowing, in order to make the soil compact, and to promote speedy germination;—of almost all field-crops, in proper conditions of soil, crop, and weather, a little after midnight in order to destroy slugs, snails, and wire-worms and various larvæ, and during the day, in order to destroy the fly or beetle;—and of flax immediately after sowing, in order to make the seeds vegetate equally, and to prevent such after-growths as tend to produce confusion and loss in all the successive stages of the process of preparing and dressing the crop. Rough rolling with Crosskill's roller, besides serving some of these purposes as well as smooth rolling, or better, is suitable for corn 3 or 4 inches out of the ground, on land infested with the grub or the wire-worm, and has been found to save crops which seemed to be threatened with destruction;—for barley or oats or other similar crop, when the plants are 3 inches out of the ground, preparatorily to sowing clover and other small seeds;—for rolling the stubbles of such crop in autumn, in winter, and once or twice in spring when the clover plants have a tendency to be thrown out;—for turnips in the rough leaf, before hoeing, when the plants are attacked by the grub or the wire-worm;—and for drilled potatoes, in order to break and press the ground between the drills, and to give it a harrowed-like surface,—three or four drills being worked at once by taking off the requisite number of roller-parts and inserting iron-bushes in the spaces, so that no roller-parts impinge on the drills to injure the plants.

ROMERIA. A small genus of ornamental, herbaceous plants, of the poppy family. The hybrid species, *R. hybridum*—ranked by Linnæus as a celandine—is an annual indigen of the hedges of some parts of Britain, about two feet in height, and carrying purple flowers in May and June. The refracted species, *R. refracta*, is a hardy annual of about a foot in height, introduced to Britain about 30 years ago from Tauria, and carrying violet coloured flowers about midsummer.

RONDELETIA. A genus of ornamental, tropical, evergreen shrubs, of the madder order. About a dozen species, varying in height from 2 to 15 feet, and chiefly carrying either white or red flowers, and loving a soil of sandy peat, have been introduced to the hothouses of Britain; and about 20 more are known. The earliest introduced species, *R. americana*, brought from the West Indies about the middle of last century, may serve as a sufficient specimen of the whole. Its stem rises 10 or 12 feet high, and ramifies on all sides; its branches are covered with a smooth greenish bark, and garnished with very close-setting foliage; its leaves are alternate, oblong, acute, entire, lucid green above, pale green below, and a little crumpled on their surface; and its flowers come out in bunches at the end of the branches, and are white and have little odour, and bloom in August.

ROOD. See Acre.

ROOF. See Farm-Buildings, Barn, and Cottage.

ROOSTING. See Poultry.

ROOT. The part of a plant which strikes downward or inward into the soil or other sources of the saline principles of vegetable nutrition. It directs its course downward or inward with a tendency apparently as invariable and stubborn as the force of gravitation; it does not carry

branches or leaves or scales in the manner of a stem; it never becomes green in its tissue by exposure to the action of air and light; and it comprises all the points of the plant's basal attachment, and also all the bibulous organs of the plant's functions of nourishment. See the article Absorption of Plants. Some cryptogams, such as many of the confervæ, have apparently no root whatever; a few cryptogams, such as the truffle, look to be all root; many cryptogams, such as the lichens and the mosses, have rather rostels than roots; some aquatic phænogams, such as the duckweeds, have only such roots or absorbing organs as float in water; many phænogams, such as the tropical orchidaceæ and other epiphytes, have only such roots as live upon trees or other plants; and some phænogams, such as many plants of the iris order,—and also some cryptogams, such as some of the ferns,—have roots more or less of the character of prostrate, thickened, underground stems. But all other plants, comprising the enormous majority of all the known flora of the world, and absolutely all which have a comparatively perfect or well-developed phænogamous character, possess true roots, or basal, compound organs of attachment and nourishment, such as we have defined. Yet these true roots present a wondrous diversity of structure and constitution and habits; and might be discussed through a long series of sections, investigating their resemblances and differences and characters and myriads of most beautiful adaptations; but, in the very limited space which we can allow to them, we must simply say, that they are usually classified into the fibrous, the bitten, the spindle-shaped, the bulbous, and the tuberous.

"In all cases," remarks Dr. Madden, "an obvious relation may be perceived between the form of the root and the kind of soil in which the plant grows. Thus, if two specimens of the same plant—some of the grasses, for example—be found growing, the one in clayey, the other in a sandy soil, it will be seen on examination, that the root of the one growing in the sand is much more minutely subdivided, and contains many more small fibres, than the one which grew in clay; and the reason of this is obvious: the spongioles are the only absorbent parts of the root,—they exist only at the extremities of the smallest fibres,—and moreover, they can take up nothing but what is presented to them in the form of solution. Now, in the clayey soil, from its retentive nature, the soluble parts are not allowed to drain away; and hence the plant is supplied with food near at hand, and, consequently, a few short fibres are sufficient. On the other hand, plants growing in sand are frequently deprived of all fluid near them, by the sinking of the soluble matters through the loosely aggregated soil; in which case the plant would inevitably perish from starvation, were it not for the wise law of Nature, which provides against such calamities, by endowing the roots of the plants, placed under such circumstances, with the power of shooting forth innumerable minute fibres in all directions, in order that advantage may be taken of every drop of moisture which falls in their neighbourhood. Nor is it merely in the number of minute fibres that the roots of plants growing in sand differ from those which inhabit the stiffer soils. The form of the body of the root is distinct; thus, nearly all bulbous, and other large succulent roots—as the turnip, for example—require sandy soil; and, moreover, some plants,—as the meadow cat's tail, or Timothy-grass, *Phleum pratense*,—change the form of the root, according to the soil they inhabit; thus, in stiff clays, the plant just mentioned has a fibrous root, whereas in sand it becomes bulbous, and assumes all the characters of *Phleum nodosum*. The explanation here is as evident as in the former case. The bulbs of the roots act as reservoirs of food for the plant; thus, in very dry seasons, these bulbs shrivel up, their fluids being all needed by the rest of the plant, and hence withdrawn. So beautifully do we perceive in this, as in all other cases, that design and adaptation of means to specific purposes, which must impress even the most sceptical with the absolute existence of a Great First Cause."

"But what gives roots their chief interest to the agriculturist," remarks Mr. J. G. Macvicar, "is the fact, that the cellular tissue, of which they are composed, is capable of becoming a reservoir of nutritious matter, which, though naturally designed for the subsequent use of the plant, man and other animals find it convenient to consume. It does not appear that sap is fit for nourishing a plant until it has been elaborated in the leaves; but it frequently happens that more can be elaborated by them at one time than is necessary for the plant's immediate consumption, in which case it is conveyed back, and stored up for future consumption, at a season when the leaves not being in a state of activity, or the soil being exhausted, there is some objection to the immediate formation of nutrient matter. In perennial plants, which form buds, this nutrient matter is usually deposited in the cellular tissue, about their roots or origin, and, when robbed by man, yields sago, and other nutritious articles of diet. When the plant is of that more perfect kind where many buds are formed, and the stem contains a decided pith, in it the nutrient grains and juices are stored, to be carried forward another season to the unevolved bud, by the ascending sap, giving it the characters of elaborated sap, and thus rendering it fit for nourishing the young leaves. But although trees, shrubs, and many forms of plants admit of this supplementary nutriment being deposited, in many little magazines, at the base of the buds,—and though the palms, and the plants which yield sago, admit of its being in one great mass, at elevations in the atmosphere,

—many other plants are of such a structure as to admit of its being deposited only near the ground, or in what we commonly call the root; and it is for the sake of this reservoir of nourishment that the farmer cultivates many crops in his fields. Just as he keeps bees in his garden, for the sake of the honey which they store up for the winter season, he keeps turnips, carrots, mangold-worzel, parsnips, and all his root crops, which have the foliage growing out of their mass in his fields, for the sake of the nourishment which they store up for the fructifying season. It will be seen, then, how much the value of such a crop depends on its obtaining from the soil a plentiful supply of nourishment; and since it is not deposited until the sap has been elaborated by the leaves, it is equally evident how conducive a healthy foliage, warmth, sunshine, and whatever is necessary to their healthy action, is to the formation of a good root. The same view enables us to understand the loss of value which a root sustains when the plant is allowed to run to seed. The nourishment is stored up chiefly for consumption at this critical period, when an exhausted soil, and an advanced season, seem to render precarious the accomplishment of that object which nature is at all times fully bent to perform, before the death of the individual. By this beautiful provision, however, the process of fructification goes on almost independent of accidental circumstances, and even though the plant be torn out of the soil; but, when this all-important end is completed, he who would now seek for nourishment in the root, will find only a husk. Nature is liberal in this, that she makes use of unconscious beings to procure food for sentient beings; but, if these sentient beings do not take the food when it is offered them, so great is her economy that she will cause the unconscious ones to devour it, that nothing may be lost. Thus, it will be seen that both meat and morality may be extracted from a turnip."

ROPE. A series of small fibres united together by twisting or spinning, which unites the fibres together, thus causing them all to act at the same time, and thereby increases the general strength; for if one fibre is weaker than another, or weaker in one part of its length than in another, it derives strength and support from the other fibres that are contiguous to it. On examining the different fibrous materials in common use according to their diameters, silk is decidedly the strongest, and flax, hemp, cotton, and other vegetable matters follow in succession. Silk and flax are too expensive to be used on a large scale, and cotton is too weak; therefore hemp is the material generally resorted to in Europe for making ropes; but different countries adopt such materials as are most convenient to themselves. Accordingly all the ropes that are used in South America and Mexico are made from the fibres of the aloe. The rigging and ropes of the native East India shipping are made from the fibrous external coat of the cocoa nut. A great deal of the rope used in the United States is called *grass rope*, which is believed to be the fibre of the *yucca*. In fact, almost any tall vegetable that possesses great strength of fibre, may be manufactured into ropes. The Society for the Encouragement of Arts, &c. in London, have paid particular attention to this subject, and by consulting the different annual volumes of their Transactions, it will be found that fine and strong thread and cloth may be obtained from the stems of the common stinging nettle and the bean, and that a coarse and strong material is yielded by the stalks of the hop plant, the bark of the lime tree, and several other vegetable productions. The value of these several materials depends, however, upon their strength and durability, and the changes that they undergo by being wet and dry, bent or straight, and under other casual circumstances; and after a fair trial and investigation of their several properties, good hemp appears superior to all that have so far been experimented upon. One of its valuable properties is that its strength is not impaired by sudden bending, while if the aloe or grass rope are so treated, as in tying a knot, they lose their strength very considerably, unless previously steeped in water; and even then, are not so strong in the bent as in the straight parts. As hemp is the best known material, and has been more experimented upon than any other, we shall confine ourselves in the few observations to be made on this subject, to ropes of this material.

When a number of small fibres are united together by the process of twisting or spinning, the thread so produced, whatever may be the material, is called a *yarn*. Yarns may be made large or small, according to the purpose they are intended for. Thus all the varieties of sewing thread, however fine they may be, consist of at least two yarns spun or twisted together. But for rope-making the yarn is much larger, and is generally about $\frac{1}{8}$th of an inch in diameter. In the British navy-yards, the size of hemp yarn is determined by its strength, for each separate yarn must be capable of supporting one hundred weight, and will therefore be a little more or less in diameter, according to the goodness of the hemp. A rope is composed of a number of these yarns, usually from 16 to 25, twisted together, and this in large ropes is called a *strand*. Large ropes are never made immediately from the yarns, but by twisting two or more of these strands together. In the language of rope-makers, three strands united, form a *hawser;* but when four are used, the rope is called a *shroud*. A *cable* is the union of three hawsers or three shrouds, and this large process of spinning is called *laying* a rope. By unravelling the end of a rope, the number of its component yarns may be readily discovered and counted, and as each yarn should bear 1 cwt., it may seem that this would offer a ready means of ascertaining the strength of new ropes. But the very formation of a rope renders this impossible. If the fibres ran in right lined directions from end to end of the rope, it would give a near approximation to truth; but the twisting of the fibres together makes the action an oblique, instead of a direct one; and thus, as those fibres near the centre of the rope, take a much straighter di-

rection than those on its outside, all the violence of the strain will fall upon the central lines of fibres, while those on the outside will scarcely feel it at all. Taking the sum of the fibres or yarns, therefore, will give no clue to the strength of a rope as they are usually made; and no rope so made can possess a strength anything like equal to what the sum of the yarns would produce or support if they could act singly. The late Captain James Huddart, of the British East India company's service, contemplating the imperfections to which large ropes were liable, from unequal or imperfect twisting, and the unequal strain to which the individual yarns were exposed in their common arrangement, invented a most admirable and simple contrivance which he called a regulator, and for which he obtained a patent, by means of which different quantities of yarn was supplied to the different parts of the strand while it was twisting or laying. That yarn that went to form the centre of the strand, never deviated from its right lined direction, while a larger quantity was given out to the outsides which had to pass obliquely, and consequently through more space, and by this means, and using a less hard twist than had formerly been resorted to, he produced the most perfect and uniform ropes, which were so perfect as to the equilibrium of their own parts, that they had no tendency to twist or recoil even when quite new; and on subjecting his ropes to experiment, it was found that instead of losing any of the original individual strength of the fibres, they assisted each other, and produced an aggregate power greater than their primitive one. Since the expiration of his patent, some of the principal rope-makers have adopted his plan of working, the advantages of which soon became known among nautical men.

The tarring of ropes can evidently add nothing to the absolute strength of the materials of which they are formed; and yet it is thought to render ropes stronger. If it does so, it can be on no other principle than that the tar cements the fibres together, and thus causes those parts to act conjointly, which without such assistance might have acted separately. The great use of tar is, however, to exclude moisture and prevent the rope from rotting, which it would do in damp situations; and it likewise prevents sand and grit getting into the inside of a rope, and these are very detrimental to ropes that are kept in constant motion, as they fret and wear away the internal fibres.

The rule that has been established by practice for ascertaining the strength of *new* ropes made of the best hemp, without tar, is that they should support one-fourth of the square of their circumference taken in inches, in tons. Thus, if a rope is $2\frac{3}{4}$ inches in diameter, its circumference may be taken at 9 inches, the square of which is 81 inches, and dividing this by 4, the quotient would be $20\frac{1}{4}$ tons, which such a rope should bear upon a fair and even strain; but as all ropes are subject to jerks and concussions, it is better to take a fifth instead of a fourth of the square of the circumference, and this would reduce the above named rope to $16\frac{1}{5}$ tons. Moreover as this rule applies to new ropes, made of the best material, and much inferior hemp is used, or cheaper materials of less strength are almost constantly mixed with it, and a rope is expected to last and wear a considerable time; so it is not prudent to put more than half this load upon a rope that is in constant use, because if strained to its full extent in the first instance, it will soon give way by use. The rule which Captain Huddart established in his rope manufactory, and upon which he would warrant all ropes made there, was to multiply the square of the circumference of the rope by 900, and this would give the number of pounds avoirdupois which the rope would sustain with safety. If we take the same example as before, of a rope having 9 inches circumference, then $9^2 = 81 \times 900 = 32\frac{1}{2}$ tons, or rather better than a third more than a rope of ordinary formation would bear.

M. Du Hamel states that tarred rope is much weaker than that which is untarred, their diameters being equal, and he gives a table of comparative experiments made with three inch rope in proof of this assertion, in which the tarred rope is in every instance greatly inferior in strength to that without tar, but he assigns no reason for this apparent phenomenon, although it is well understood by every rope-maker. They usually demand the same price for tarred rope as for that which is clean, and even sometimes make a favour of charging nothing for the tar and trouble of applying it. But the fact is, the tarring is always performed upon the separate yarns, by drawing them through a kettle of boiling tar, before they are twisted into strands. The hot tar swells the fibre, and a quantity of it adheres to each of them, so that the diameter of the yarn becomes sensibly increased, and of course a much less number of yarns become necessary to form a rope of the same diameter, than if clean hemp was used. This is quite sufficient to account for the deficient strength of tarred ropes; but if, instead of comparing the ropes by their diameters, they were compared by the number of yarns they contained, then the tarred rope would, it is believed, have the advantage. The inexperienced purchaser when he buys a tarred rope, does not usually consider that in each pound of rope he buys, he gets about 14 oz. of hemp and 2 oz. of tar, which are both sold for the same price, although hemp is at least sixteen times more costly than tar. M. Du Hamel, however, goes on to state, that it is decided by experience that white cordage in continued service, is one-third more durable than tarred; that it retains its strength much longer while kept in store; and that it resists the ordinary injuries of the weather one-fourth longer. These observations deserve the attention of practical men, being very important. There is, however, a reason why tarred ropes should be used in particular cases, such as the standing rigging of ships, or that which does not require to be run over pullies or to move; such as the main-stays, fore-stays, and shrouds, by which the masts of vessels are held and maintained in their vertical positions. The reason is that all untarred

cordage (particularly when new) is highly hygrometric, and expands and contracts in its length to a great extent by being dry and wet. The damp state constantly producing contraction, and the dry one extension. This contraction by wetting exercises so much force, that if a rope is fully stretched in its dryest state, and then wetted, it will break, or tear away the parts to which the ends are attached if they are less strong than the rope. If, therefore, a mast was braced in its proper position by dry white ropes, a shower of rain would probably bend the mast or break the ropes. On the contrary, if the mast was braced as tightly as possible by damp ropes, a few hours sunshine would render it quite loose. Anything therefore that will destroy the hygrometric properties of the rope by rendering it less, or not at all absorbent of humidity, will be beneficial in such cases; and tar or paint answers this purpose.

Ropes are always sold and valued by weight, but are described by their circumference in inches. Thus what is called a 3 inch rope would only be about 1 inch in diameter, and when a 24 inch cable is spoken of (being the largest size usually made), a cable less than 8 inches in diameter is understood. See Leather-Bands.

ROPE-GRASS. See Restio.

ROSA. See Rose.

ROSA MARIÆ. See Anastatica.

ROSCOEA. A genus of ornamental, tropical, perennial-rooted, herbaceous plants, of the scitamineous order. Five species, all about a foot high, and carrying purple flowers in July and August, and thriving best in a soil of sandy loam, were introduced to British collections about 28 years ago from Nepaul.

ROSE,—botanically *Rosa*. A large genus of ornamental, calyciflorous shrubs, constituting the type of the natural order Rosaceæ. This order is, in a very considerable degree, identical with the Linnæan class Icosandria; and though of very great extent, and quite naturally distributable into distinct groups or tribes, it possesses remarkable uniformity of botanical character,—insomuch that all its genera, no matter how diverse in habit or how peculiar in general appearance, may be considered as mere proximate and easy variations from the true rose genus. It is at once one of the largest, one of the most magnificent, and one of the most grateful of all the natural orders. It comprises many plants of rich and diversified medicinal virtue,—some plants of considerable utility in the arts,—multitudes of plants of rare beauty and elegance and fragrance,—very many of the most valuable or most ornamental plants of hedges, shrubberies, and pleasure-grounds,—and all the most important fruit-trees and fruit-shrubs of the temperate regions of the world. Eight tribes, and about 50 genera, and nearly 1,000 species of it, besides myriads of varieties of its finest flowering and fruiting plants, at present occur in Britain; and more than three-fifths of all the species are hardy shrubs or hardy trees,—and a good deal more than one-fourth are hardy herbs,—while only about one-ninth require the protection of the greenhouse or the stove. The tribes which contain the greatest number of genera are dryadeæ, sanguisorbeæ, and pomaceæ; two tribes which contain each only one genus are roseæ and neuradeæ; and the other three tribes are amygdaleæ, spiræaceæ, and chrysobalaneæ. Some of the best known or most interesting genera, additional to the true rose genus, are the strawberry, the potentilla, the bramble, and the avens, belonging to the tribe dryadeæ,—the great burnet and the ladies' mantle, belonging to the tribe sanguisorbeæ,—the hawthorn, the medlar, the quince, the cotoneaster, the loquat, and the pear and apple and service, belonging to the tribe pomaceæ,—and the almond, the peach, the apricot, the plum, and the cherry, belonging to the tribe amygdaleæ.

The petals of a rose are five in number; the calyx is pitcher-shaped, five-cleft, fleshy, and contracted in the neck; and the seeds are numerous and hispid. Twenty-two species grow wild in Britain; about 100, or upwards, have been introduced from other countries; and about 40 more are known. Hybrids and varieties of most of the finer species have also been multiplied beyond number. A few of the species, comprising a multitude of varieties, are evergreen shrubs; a few, comprising very many varieties, are either climbing or trailing shrubs; and the vast majority, as well of species as of varieties, are upright deciduous shrubs. One subgenus, represented by the Scotch rose, has equal, numerous, bractless prickles, persistent connivent sepals, and scarcely any disc; another, represented by the Cinnamon rose, is bracteate and unarmed, and has glandless lanceolate leaflets, and a slender disc; a third, represented by the Provence or hundred-leaved rose, has unequal bracteate prickles, rugose leaflets, and a thick disc surrounding the throat; a fourth, represented by the rusty sweet briar, has arched branches, unequal prickles, glandular leaflets, persistent sepals, and a thick disc; a fifth, represented by the dog-rose, has arched branches, equal hooked prickles, glandless leaves, deciduous sepals, and a disc surrounding the throat; a sixth, represented by the villous rose, has erect branches, straight prickles, persistent connivent sepals, and a thick disc surrounding the throat; a seventh, represented by the clustered-styled rose, has its styles joined into a long column, and has also adnate stipules; and four other but very small subgenera, aggregately comprising less than a dozen species, have characters different from all these seven and from one another. But the families into which horticulturists and florists and nurserymen distribute roses amount to upwards of thirty, and comprise only the ornamental sorts, and have little or no reference to

proper botanical characters, and are so fused into one another as to defy the efforts of all but the most studious amateurs to trace them; and some even consist entirely of fancy varieties, and have been grouped, not on any principle of constitution or form or habit, but on the preposterous ground of mere parentage. Even the present botanical classification is difficult to a novice, and has been in a considerable degree stultified and confounded by the multiplication of all sorts of hybrids; and the present horticultural classification is both absurd and bewildering, and has for a long time become increasingly uncertain and unsettled, and not only wants proper characters for its families, but distributes some classes with very distinct natural characters through two or three or even a larger number of its groups. If the properties of climbing and dwarf, of solitary-flowered and bunch-flowered, be adopted as subdivisional characters, four families, the China rose, the double garden rose, the perpetual rose, and the briar-rose, might probably be made to comprise all the eleven hundred varieties or so which at present figure in the best floral catalogues. The China might comprise all the present China, the tea-scented, the miniature, and such of the bunch-flowered or noisette as have smooth wood and continuous growth, and might be subdivided into the climbing, the climbing noisette, the dwarf, and the dwarf noisette; the double garden might comprise all the deciduous kinds, or all the out-of-door summer-blooming sorts, except the perpetual and the moss; the perpetual might comprise the moss-roses, and all the other sorts which send out a succession of blooms till a late period in autumn,—and both this and the double garden might be subdivided in the same manner as the China; and the briar-rose might comprise all the sorts, whether true briars, or Scotch roses, or whatever else, which have short joints, and flower all along the stem, and are perfectly deciduous.—We shall, in the sequel of this article, first notice some of the most remarkable species; next, give a brief general notice or two respecting the finest garden varieties; and next, say something respecting the culture and propagation of the garden varieties.

The dog-rose, *R. canina*, is common in the hedges of Britain, and in most parts of Continental Europe. It is a beautiful wild ornament, and exhales a delicious fragrance. Its stem is smooth, and has pairs of alternate, equal, hooked, bright-red prickles, and sends out elongated, arched, spreading branches, and rises to the height of 8 or 10 feet; its leaves are pinnate, and have each seven leaflets, and stand on glandular, pubescent, prickly footstalks; its leaflets are ovate, pointed, and smooth, and have a shining upper surface and a deeper green under one; its flowers come out on either solitary or corymbose peduncles, and are odorous and either white, or flesh-coloured, or pink, and bloom in June and July; and its fruit is the well-known common hip or hep,—an ovate, smooth, fleshy, red-berry-like calyx, containing about 30 long angular seeds within a loose packing of white, silky, irritating bristles. Some distinct varieties, such as the needle-leaved, the grey, the hill, and the thicket, occur wild in Britain; and some ornamental varieties, such as the Bourbon, Schott's, and the Egyptian, have been introduced from other countries, and are cultivated in gardens. The fruit of the dog-rose has a place in the pharmacopœia, and possesses cooling properties, and is used in the form of a confection. Its sweet, pleasant, acidulous taste depends on sugar and uncombined citric acid.—Six indigenous species, Sherard's, Forster's, the naked, the twiggy, the spriggy, and the bractescent, belong to the same subgenus as the dog-rose; and all these occur in hedges, and have pink flowers, and bloom in June and July,—two of them, the twiggy and the spriggy, have a trailing or procumbent habit, and are one-half or two-thirds as long in the stem as the dog-rose,—and the other four have an upright habit and an average height of about 6 feet. The China roses, the Boursault roses, and the small-leaved roses,—the first introduced from Bengal about 60 years ago, the second originating in a hybrid in 1821, and the third introduced from India in 1823,—also belong to the dog-rose subgenus.

The Scotch rose or spiniest rose, *R. spinosissima*, grows wild on sandy heaths in Scotland, England, and most parts of Continental Europe. Its height is commonly about 2 or 3 feet, but varies with soil and culture and variety; its branches or shoots are numerous, upright, and very prickly or briary, and are smartly set off with beautiful foliage; its leaves are pinnate, and of a fine green colour, and more delicate than those of any other rose; its leaflets are small, and stand along the midrib in the manner of those of the burnet; its flowers come out in great profusion over the whole length of the stems or branches, and are small and of a white and red colour and almost like the flowers of briars, and bloom in June and July; and its fruit or heps have the appearance of black-berries, and are highly ornamental in autumn and winter. Numerous varieties are cultivated in gardens, and look exceedingly pretty in clumps or on a bank, but are not adapted to be grown as standards.—Four indigenous species, and two admired horticultural exotic species, belong to the Scotch-rose or pimpinella-leaved subgenus,—the reddish rose, *R. rubella*, inhabiting the sea-shores of some parts of England, carrying pink flowers in June and July, and including a black-fruited variety,—the eglantine, *R. eglanteria*, commonly about 4 feet high, carrying yellow flowers in May and June, and including one or two wild varieties,—Sabine's rose, *R. Sabini*, inhabiting the woods of various parts of Britain, attaining an average height of about 8 feet, and carrying

white and red flowers in May and June,—Don's rose, *R. Doniana*, inhabiting the hedges of various parts of Britain, attaining an average height of about 4 feet, and carrying pink flowers in May and June,—the alpine rose, *R. alpina*, introduced from Switzerland in the latter part of the 17th century, carrying pink flowers in June and July, and comprising at least a dozen well-defined varieties, differing from one another in height, in colour of flower, in habit, and in other characters,—and the double sulphur rose, *R. sulphurea*, introduced from the Levant in the former part of the 17th century, attaining an average height of about 3 feet, carrying yellow flowers in July, and constituting a beautiful and much-admired object, but remarkable among roses for great shyness and difficulty of cultivation.—The briar-roses, which possess considerable affinity to the Scotch roses, though they constitute a different family in the horticultural classification, and also a distinct subgenus in the botanical arrangement, are noticed in the article Briar (Sweet).

The villous rose or apple rose, *R. villosa*, grows wild in the hedges of various parts of Britain, and in most parts of Continental Europe. Its average height is about 6 feet; its shoots are strong and bold, and have a smooth reddish bark, and readily distinguish it in winter from all other roses; its prickles are thinly placed, and very strong and sharp; its leaves are large and very hairy, and have a downy under-surface; its flowers are red or pink, and bloom in June and July; and its fruit are as large as small apples, and are beset all over with soft prickles, and give the plant a singular appearance, and, when preserved, make a very pleasant sweetmeat.—Four other indigenous species belong to the same subgenus as the villous rose,—the slender, *R. gracilis*, inhabiting highland glens, attaining an average height of about 8 feet, and carrying red flowers in June and July,—and the rougher, the various-leaved, and the downy-leaved, *R. scabriuscula*, *R. heterophylla*, and *R. tomentosa*, all inhabiting hedges, and attaining an ordinary height of about 6 feet, and carrying pink flowers in June and July.—The Irish rose, *R. hibernica*, and the white rose, *R. alba*, also belong to this subgenus,—the former peculiar to Ireland, and inhabiting thickets in that country, and having an ordinary height of about two feet, and carrying pink flowers from June till November,—and the latter introduced to Britain from the Crimea toward the close of the 16th century, and having an ordinary height of about 4 feet, and characterised by green shoots, glaucous green leaves, prickly petioles, hispid peduncles, and smooth, oval germens, and comprising many garden varieties of all colours from pure white to a bright but delicate pink.

The Provence rose or hundred-leaved rose, *R. centifolia*, was introduced to Britain from the South of Europe toward the close of the 16th century. It is the prince of flowers, and has for ages been an universal favourite, and is cultivated in almost every region of the civilized world, and has a place in all sorts of gardens from the poorest to the most magnificent; yet it cannot be certainly traced to its origin,—though it is variously said by some rare ancient and modern writers to grow indigenously in Macedon, in China, and in Northern Persia. It comprises some very distinct varieties, and a great multitude of subvarieties and hybrids; and it may be regarded as having the well-known old cabbage rose as its type. Its stem is branched and bushy and about 3 feet high; its leaves are compound, and have rough footstalks, and comprise each two or three pairs of leaflets, and a terminating odd one, all on very short petioles; its leaflets are broad, oval, smooth, and serrated,—deep green above, hairy below, and purple on the edges; and its flowers are large, and stand on brownish bristly footstalks, and have semi-pinnate calyx segments, and very numerous, extremely fragrant, beautiful, pale red petals, and bloom from June till August. The petals of this rose are distilled with water for yielding the exquisitely odorous attar of roses, one of the richest and most costly perfumes; and they at the same time strongly impregnate the water with their odour, and yield the well-known rose water of perfumers and druggists. The petals are likewise used in medicine; they have a sweetish, subacidulous, and eventually somewhat bitterish taste; they possess slightly laxative properties; and they are made up with sugar into a syrup, which is given along with other gentle aperients to infants. — The moss-rose, and the pompone rose,—the former characterised by the mossy appearance of its peduncle and its calyx, and both comprising many most beautiful subvarieties—are simply varieties of the Provence rose, and botanically bear the names of respectively *R. c. muscosa* and *R. c. pomponia*. But the hybrid Provence roses, constituting a large family in the common horticultural arrangement, are intermediate between the Provence rose and the French rose, and have the dense foliage of the one and the long shoots of the other.

The French rose, *R. gallica*, grows naturally in most parts of Continental Europe, and was introduced to Britain toward the close of the 16th century. It belongs to the same subgenus as the Provence rose. Its stems rise two or three feet high, and are erect and almost destitute of prickles; its leaflets are subacute, and not so large as those of the Provence rose, and scarcely tomentose below; and its flowers are not so double as those of the Provence rose, and have large, widely open, deep rich crimson coloured petals, and bloom in June and July. About two hundred varieties and subvarieties are cultivated in gardens; and they are distributed by some cultivators into two groups,—the one with self-coloured and shaded flowers, and the other with

variegated flowers. The full flower-buds of the French rose are used in medicine, and are extensively raised for medicinal purposes in the vicinity of London. They are less fragrant than the flowers of the Provence rose; but they improve by drying. They have a pleasantly bitter and austere taste; and they yield both their taste and odour to boiling water. They possess astringent and tonic properties; and are pharmaceutically prepared in the forms of infusion, confection, honey, and syrup.

The damask rose, *R. damascena*, belongs also to the same subgenus as the Provence rose and the French, and was introduced to Britain from the Levant 20 or 25 years earlier than either. It has an average height of about 3 feet; and carries pink-coloured flowers in June and July; and is sometimes confounded with the normal Provence rose; and comprises a very great number of garden varieties. The family of the damask rose, however, as usually grouped in catalogues and collections, is one of the most incongruous of all the horticultural families, and comprises not only a wide diversity of colours, such as white, white and red, flesh-coloured, striped, and red-margined, but also the most discrepant characters, and even perfectly contrasted habits.

The musk rose, *R. moschata*, was introduced to Britain from Barbary toward the close of the 16th century. It is an evergreen, and belongs to the clustered-styled subgenus, and has long been a great and general favourite. It is naturally a trailing or a climbing plant of about 12 feet in length; but, when planted singly, it forms itself into an erect bush of 5 or 6 feet in height. Its stems are clothed with a green bark, and armed with strong, crooked, white spines; its leaves are five-lobed, smooth, and lucid green, and make a fine appearance in winter; its lobes or leaflets have acute points, and are slightly sawed on their edges; and its flowers come out in large bunches at the end of the branches, and are white, and have a strong musky odour, and bloom from July till October. A few varieties of it of very distinct character occur in gardens, some evergreen and others deciduous,—some not more than 4 feet high, and one so much as 30 feet high; but the family of musk roses, in the common horticultural arrangement, partakes largely of the uncertainty and confusion which prevail so generally through that arrangement.—Two indigenous species, the clustered-styled rose, *R. systyla*, and the corn white dog rose, *R. arvensis*, belong to the same subgenus as the musk rose,—both inhabiting the hedges of various parts of Britain,—the former about 6 feet high and carrying pink flowers from May till July,—and the latter about 8 feet high and carrying white flowers in June and July.

The garden rose is the only flower which is beautiful in all its stages, from the instant of its incipiently bursting the calyx till it attains full bloom; it is also the only flower which is really rich in its confusion, or which is not the less elegant for the total absence of all uniformity and order; it likewise possesses points or developments which rank as excellencies in one group and as blemishes in another; and it therefore is more difficult of definition than any other florist's flower. Yet some very distinct properties can be named as essential to goodness in all roses whatever; and other and additional ones, as essential to all the varieties of each of some of the principal groups.—As to all roses whatever,—1. The petals should be thick, broad, and smooth at the edges. Whether this be for a moss, which is never to be shown fully opened, or the florist's favourite, which is to be shown as a dahlia, this property is equally valuable, because the thicker the petal the longer it is in opening, and the longer does it continue in perfection when it is opened. The thicker the petal, too, the more dense and decided the shade or colour, or the more pure a white; while the most brilliant scarlet would look tame and watery if the petal were thin, transparent, and flimsy. 2. The flower should be highly perfumed. Whether the plant climb the front of a house, or bloom on the ground, or mount poles or other devices, fragrance is one of the great charms which place the rose on the throne of the garden as the queen of flowers. 3. The flower should be double to the centre, high on the crown, round in the outline, and regular in the disposition of the petals The more double the flower, even when amounting to confusion, the more full and beautiful the bud in all its stages. Those who have noticed the single and semi-double moss-roses will remember that the buds are thin and pointed, and starved-looking affairs, while the old common moss-rose, which is large and double as the cabbage-rose, is bold, full, rich, and effective, from the instant the calyx bursts.—As to every moss-rose, the quantity of moss, the length of the spines which form it, and its thickness or closeness on the stems, leaves, and calyx, cannot be too great; the length of the divisions of the calyx, and the ramifications at the end, cannot be too great; the plant should be bushy, the foliage strong, the flowers abundant and not crowded, and the bloom well out of the foliage; the colour should be bright or dense, as the case may be, and must be the same at the back as the front of the petals; and the stem should be strong and elastic, and the footstalks stiff, so as to hold the flower well up to view.—As to all roses for stands, designed to be set out in detached flowers like dahlias, the petals should be imbricated and in distinct rows, whether they be reflexed, like some of the velvety tuscan kind, or cupped like a ranunculus, and the petals to the centre should continue the same form, and only be reduced in size; the colour should be distinct and new, and stand fast against the sun and air, till the bloom fail; the stem should be strong, the footstalk stiff and elastic, the blooms well out beyond the foliage, and not in each other's way. The very worst habit a rose can have is that of throwing up several blooms close together, on short stiff footstalks, some of which must be cut away before the others can be fully developed; as show-flowers they are bad, and as plants they are very untidy; the side buds prevent the centre flowers from opening circularly, and when the first beauty is off them, they exhibit dead roses held fast between two living ones.—As to all noisette roses, the cluster should be sufficiently open to enable all the flowers to bloom freely, and the stems and footstalk should be firm and elastic, to hold the flower face upward, or face outward, and not to hang down, and show the outside, instead of the inside of the blooms; the bloom should be abundant at the end of every shoot; the blooming shoots should not exceed twelve inches before they flower; the bloom should stand

out beyond the foliage; and the plant should be compact and bushy.—And as to climbing roses, the joints should be short from leaf to leaf; the blooms should come on very short branches, and all up the main shoots; the plant should be always growing and developing its flowers from spring to autumn; and the foliage should completely hide all the stems, whether the plant be on front of a house or on any given device.

Some of the horticultural families have hardly a good rose among them; and others have far fewer good ones than bad. In fact, nine-tenths or so of the varieties enumerated in catalogues are not worth possessing, either on account of their intrinsically bad properties, or because two or three or more of them are so closely like one another as to be practically one. Mr. Rivers gives upwards of a thousand professedly select varieties in thirty-three families, and makes out of this great multitude a selection of six of the largest, six of the sweetest, six of the most brilliant, six of the strongest, six of the finest shaped, six of the earliest small, six of the earliest large, and six of the latest; and this selection is probably the best guide which a purchaser can follow, if not to actual varieties, at least to groups and numbers. The six largest are La Reine, rosy pink,—William Jesse, light crimson tinged with lilac,—Souvenir de la Malmaison, pale-fleshed tinted with fawn,—Calypso, pale rose,—Brennus, bright red,—and Chenédolé, vivid crimson; and these comprise two perpetual, one Bourbon, two hybrid China, and one which partakes much of the character of a hybrid Chinese. The six sweetest or most fragrant are Riego, a sweet briar,—Crested Provence, an ordinary rose colour,—the common Cabbage-rose, an old favourite,—the common Moss-rose, also a universal favourite,—Crimson Perpetual, bright crimson,—and Prince Albert, purplish crimson; and these six comprise no less than four families—one being a perpetual, one a hybrid perpetual, one a hybrid sweet briar, two Provence, and one moss. The six most brilliant are Vesta, a very old variety,—Rouge Eblouissante, or Assemblage des Beautés,—Eblouissante de Lequeue,—Feu Brilliante,—Grande Capitaine,—and Gloire de Rosamène; and four of these belong to the family of Rosa Gallica, and two to the family of Bourbon. The six strongest or most vigorous growing are Great Western, deep reddish crimson,—Hortensia, bright pink,—Charles Duval, bright rose,—Paul Perras, brilliant shaded rose,—Elise Mercœur, rose colour with red centre,—and Chenédolé, already noticed in the first six; and here we have five hybrid Bourbons, so called, and one hybrid China. The six finest shaped are Triomphe de Jaussens, brilliant crimson,—Kean, nearly scarlet,—Coupe d'Hébé, delicate rose colour, often shaded with pink,—La Volupte, deep rose,—Rose Devigne, a delicate pink,—and Boula de Nanteuil, crimson purple. The six earliest small are Spong's Rose, bright rose colour,—Rose de Meaux, an old acquaintance,—mossy Rose de Meaux, or Pompone, beautifully mossed,—Persian Yellow, bright gold colour,—Chinese Sweet-briar, bright pink rose,—and Burgundy, an old dwarf rose. The six earliest large are George the Fourth, Ne Plus Ultra, Fulgens, Blairii No. 2, Magna Rosa, and Triomphe d'Angiers,—all hybrid China roses. And the six latest are Madame Laffay, rosy crimson,—Lady Alice Peel, deep pink,—Baronne Prevost, rosy blush,—Doctor Marx, rosy carmine,—Duchess of Sutherland, bright rosy blush,—and Mrs. Elliott, light crimson tinted with lilac; and all these are perpetuals, or hybrid perpetuals.

The proper soil for the rose is strong rich loam, and either well decayed vegetable mould, or cow-dung or horse-dung. If the soil be light, holes must be dug, and loam and dung forked in; for troublesome as this may be, it is the only way to secure a good growth and bloom. Among the evils of poor soil, it is not the least that it frequently makes the flower that would otherwise be double come single or semi-double, so as to destroy all identity of the variety by its bloom; and although many thousands of roses not worth a penny have been sent out, many others thoroughly good have been condemned, because the party growing them knew nothing about their cultivation, and starved them into a false character. "The rose, perhaps, more than any other ornamental shrub," remarks Mr Rivers, "requires constant culture to make it bloom in perfection, unless in the most favourable rose soils. Roses require to be removed, and to have their roots trimmed, every third year. When taken up, these roots will be found to have lost most of their fibres; but, naked as they are, if they are then trimmed, the branches thinned and shortened, and plenty of well-rotted manure mixed with the soil they are planted in, the plants will be quite renovated, and bloom as fine, and often finer, than young plants. This treatment, perhaps, is most applicable to standard roses. With dwarfs the trouble is too much, unless with the choicest sorts, as they are sold at such low prices, that it would be cheaper to make a new plantation. In very clayey cold soils, the finest compost possible for roses is well-rotted dung and common-pit sand, not road sand, equal parts. When standards are removed, they ought to have their heads thinned, and shoots shortened early in spring. A mistaken notion, which I often find current, is, that they ought to push, that is, begin to shoot, before the branches are shortened; this has sealed the doom of very many standard roses. I have an idea that standard China roses, of the most choice varieties, with stems from 3 to 4 feet, might be made highly ornamental summer plants. They are too tender to endure the ordinary severities of our winters as standards; but if taken up every autumn, put into large pots, and placed in a dry shed, they would remove into their summer quarters in the spring with perfect safety, and bloom much finer than if exposed during winter, and their shoots injured by the severity of the weather. The varieties of *Rosa indica odorata* bloom exceedingly well in this manner, as do all the strong-growing varieties of China roses. *Rosa Grevillii* and *multiflora* also form curious objects, and bloom very freely, when grown as standards. The hardy climbing roses, and several of the climbing China roses, form fine objects when trained *en pyramide*, that is, in the French manner of training pear trees; but when trained in this manner, as climbing roses do not form a stem strong enough to support themselves, the strong central shoots must be tied to iron or wooden stakes, and the side shoots from them shortened every season; in this manner, with proper culture, they will form pillars of roses, from 6 to 10 feet in height. * * * Standard roses always appear to me to have the prettiest effect when budded on neat stems, varying from 1 foot to 4 feet in height; they are more easily removed, are nearer to the eye, and their perfume is more readily inhaled. They will soon get over the habit of throwing up suckers, which with some is an objection, if care is taken when they are removed, to disbud the lower part of the stem, and to take off those roots which seem to have a tendency to throw up suckers. When thus treated, they form pretty compact heads, and yet not lumpish, if properly pruned. A prejudice is often found to exist against budded roses, and this has arisen principally on account of improper stocks being used. Most decidedly, roses never bloom so finely as when budded, and the most proper and durable stock is *Rosa canina* with its varieties; while *Rosa arvensis* is, perhaps, the worst."

The China rose, and all the short-jointed, smooth-

barked kinds that are like them in habit, will strike, bud, graft, grow and bloom, any month in the year. The only thing necessary, is to have plants in all stages, and there will never be any want of flowers. In the greenhouse they continue growing on, and blooming at all times; but they cannot be kept too cool generally, and if abundance of flower is required on a plant, it must have a previous rest, and shift to a warm temperature, and if matted in the roots, a large pot, and the heat gradually increased until it will bear that of a moderate stove. All the new young growth will flower about the same time, or at least sufficient of it to well decorate the plant. Cuttings may be struck in the spring, planted out in beds, six inches apart, to grow a little; the tops be pinched off, and the buds taken away all the summer, to make them bushy; and they may be potted up into forty-eight sized pots, half loam, a fourth peat, and a fourth cow dung; trimmed a little into shape, and placed in the shade a while. In September they may be put into their frames, covered up at night against frosts, and opened in mild weather, until the middle of November; they may then be removed, a few at a time, into an increased temperature, and about a month apart. They will be found to bloom well, and succeed each other admirably, all through the winter and spring, before those out of doors can even fairly start into leaf; the only care required being to syringe them against the green fly, and if that does not keep them under, fumigate them,—and to see that they never suffer from want of water. These, however, as also summer roses, will force better the second year than the first, by shifting them into pots a size larger, trimming the plants into a proper shape, taking away the weak shoots, letting them rest, and giving but little water towards the end of the summer, except to keep them from actually flagging; putting them in their frames and removing them into heat as before, a few at a time, and a month apart. Plants of the Provence, moss, white, Damask, Tuscany and other families may be brought into the forcing house at any time from November till March, according to the season when the flowers are required; and if they are brought in at different times, they should be marked with their respective dates of introduction; and they should have a soil and root-seat as nearly as possible like those which best suit them in the open ground; and while growing, they should be watered two or three times a-week with river water or with liquid manure.

Roses are propagated from seeds, cuttings, layers, suckers, buds, and grafts. Seeds are used only when new sorts are desired; and they may be sown either on a prepared bed, or in boxes filled with very light soil, and protected in winter. Cuttings are used chiefly for the evergreen sorts; and they should be taken from the young shoots of the same year, and have each from four to six joints, and be planted in a mixture of leaf-mould and very light soil, either in pots or under a hand-glass. Layers can be put down at almost any time of the year, but do best in July, when the plants are in flower. Suckers need only to be dug up, with as much root as possible, at any time during the winter. Buds and grafts are managed in the way described in the articles Budding and Grafting. The insect devastators of rose plants are many and very mischievous; and will be noticed in the article Rose-Moth.

River's Rose Amateur's Guide.—River's Rose Catalogue.—Glenny's Properties of Flowers and Plants.—Lindley's Rosarum Monographia.—Loudon's Hortus Britannicus.—Loudon's Encyclopædia of Gardening.—Hereman's Blight on Flowers.—Miller's Gardener's Dictionary.—Marshall's Treatise on Planting and Rural Ornament.—The Horticultural Magazine.—The Gardener's Magazine.—The Gardener's Gazette.—Thomson's Dispensatory.

ROSE ACACIA. See Acacia Tree.

ROSE-BAY. See Nerium.

ROSE CAMPION. See Lychnis.

ROSE (Japan). See Camellia.

ROSEMARY,— botanically *Rosmarinus.* A small genus of hardy, ornamental, evergreen shrubs, of the labiate order. The officinal species, *R. officinalis*, is a native of Barbary and the South of Europe, and was introduced to Britain about the middle of the 16th century. Its stem is erect, and very branching and shrubby, and about 4 feet high; its branches are densely clothed with foliage,—and the smaller ones are quadrangular and downy; its leaves are opposite, almost sessile, linear, obtuse, entire, reflexed, upwards of an inch long, about one-sixth of an inch broad, smooth, shining and dark green above, and veined, woolly, and silvery-tinted below; its flowers are axillary and terminal, and stand on short footstalks, and have a campanulate, bilabiate, villous calyx, and a ringent, downy, pale blue corolla, variegated with white and purple, and bloom from February till May; and its seeds are four in number and oblong in form, and lie in the bottom of the calyx. This plant has long been cultivated in kitchen gardens for medicinal purposes. Its tops, or leaves and flowers, have a grateful aromatic odour, and a warm, pungent, bitterish taste; and are used for strewing in sick-rooms, for affording an essential oil, for perfuming medicinal snuffs, and for making infusions or remedies for hysteria, chlorosis, and nervous headache. The essential oil possesses fully, and the tincture very considerably, the same stimulating and aromatic properties as the tops; but these preparations, as also the tops themselves, are now far less in request than in former times,—and really do not seem to deserve much attention. Three distinct varieties of the species occur in gardens,—the silver-leaved, the gold-leaved, and the broad-leaved; and the two last of these are much taller than the normal plant. Rosemary thrives best on a poor gravelly soil, containing calcareous admixtures; but it succeeds well on any common soil. It may be raised on a shady border, in spring or summer, from slips or cuttings, properly watered, or from seed sown broadcast, and thinned to six inches apart; and when the young plants get properly advanced, they should be transplanted as required, and either allowed to grow in a head, or trained in a fan manner.

ROSEMARY. Three hardy, perennial-rooted herbs, belonging to three several genera of the umbelliferous order. One, *Athamanta libanotis*, is a white-flowered weed of the chalky pastures of England, about 2 feet high, and blooming in June and July; another, *Cachrys libanotis*, was introduced nearly 3 centuries ago from Sicily,

and has a height of about 3 feet, and carries yellow flowers in July and August; and another, *Laserpitium libanotis*, was introduced about 50 years ago from Germany, and has a height of about 20 inches, and carries purple flowers in June and July.

ROSEMARY (Wild). See Andromeda.

ROSE-MOTH,—scientifically *Argyrotoza Bergmanniana* or *Tortrix Rosana*. A very beautiful and very destructive moth of the Tortricidæ family. It acts a prominent part in the devastating of rose plants, but is far from being alone in that work. "There is scarcely any plant," says Mr. Westwood, "which is more liable to the attacks of insects than the rose. Not to mention the aphides which occasionally swarm to so great an extent, at certain seasons, on particular varieties, as to render the plant too weak to be able to accomplish its flowering; the saw-flies, several species of which feed upon the leaves, in the larvæ state; the mining *Tineæ*, whose larvæ render the leaves unsightly by tracing their serpentine track within the substance of the leaf; the leaf-cutter bees, *Megachile*, which cut out circular patches from the leaves to form the lining of their cells; or a species of the curious genus *Lyda*, belonging to the family Tenthredinidæ, which constructs a large portable case of pieces of the leaves, which it ingeniously cuts out, and then fastens round its body in a spiral direction, a course of proceeding quite unlike anything hitherto observed in the family to which it belongs; there are yet several small species of moths, which in the caterpillar state are still more injurious than all these, by gnawing away the tender parts of the shoots and buds whilst very young, so that, when the bud attains its full size, it is found to have half of the petals devoured; besides the ugly appearance given to the plant by the leaves being fastened together, prevented from assuming their ordinary elegant appearance, and partially devoured. Hence, it will be easily conceived that these insects are far more obnoxious to the rosarium than any of the others mentioned above; and, indeed, they are sometimes so numerous, especially in the early blowing varieties, that it is as common to hear the ordinary presence of a blight on the rose-trees attributed to the appearance produced by an attack of these insects, as upon any other tree."

The principal moths which attack rose-plants in this way are *Lozotœnia rosana*, *L. oporana*, *L. nebulana*, and *L. lœvigana;* the *Spilonota aquana* and the *Pterophorus rhododactylus* are also rose-feeders; the *Dictyopteryx Forskaoleana* destroys centifolious roses; the *Spilonota cynosbatella* either feeds on rose-buds, or forms rose-leaves into a web in preparation for its pupa state; and the *Antithesia salicella* feeds so, in its caterpillar state, on the leaves of the centifolious rose, as to be sometimes called the Provence rose-moth. But the *Argyrotoza Bergmanniana*, as we have said, is the most destructive of all. It is one of the smallest and most splendid of the Tortricidæ; and is described as follows by Mr. Stephens:—"Anterior wings yellow, clouded with fulvous, and obscurely reticulated with the same, with four slightly curved, nearly equidistant streaks of silvery dots,—the first abbreviated and near the base, the second before the middle, the next rather behind, extending obliquely to the anal angle, and the fourth on the hinder margin itself; cilia pale yellow; posterior fuscous, with dirty yellow cilia; head and thorax sulphur-yellow. Extremely abundant in hedges and gardens, by the sides of woods, &c., throughout the metropolitan district, and in most parts of England, at the end of July and beginning of August." The caterpillar is only about four lines long, and has a fleshy consistence, and a dark flesh colour, with a black shining head; and the crysalis has a pale reddish brown colour, and is of the ordinary form, without any of the angular projections which occur in the crysalides of some butterflies. The caterpillar is the depredator, and commences its attacks on the leaves as soon as they appear, and works two or more of them into a packet or pouch for affording itself retreat and subsistence, and burrows in the young flower-buds in order to feed upon the petals, and finally provides a retreat among the foliage for undergoing its transmutation into a crysalis.

"The extirpation of these insects," remarks Mr. Westwood, "is matter of difficulty. They are, it is true, very conspicuous in the winged state; and, if care were taken to employ children in catching and killing them just at the time when they make their appearance as moths, the laying of the eggs would be prevented, and the trees saved from the next year's broods. Bouché, however, recommends brushing the twigs of the rose in the winter with a stiff brush, which would have the effect of destroying the eggs; but as these are deposited in the most secure places, at the roots of the eyes and under the base of the young twigs, there is some danger and much difficulty in this method. An inspection of the trees in the early spring, before the insects have done much damage, will easily show the places of lodgement of the larvæ, which may then be readily destroyed by the hand."

ROSE OF HEAVEN. See Lychnis.

ROSE OF JERICHO. See Anastatica.

ROSE ROOT. See Rhodiola.

ROSE SNOWBALL TREE. See Guelder Rose.

ROSIL, or Rosills. Land of medium mechanical condition between light and heavy, or between sand and clay.

ROSIN. See Resin.

ROSMARINUS. See Rosemary.

ROSTEL. The organ of mechanical attachment possessed by rock-inhabiting cryptogams in lieu of a root.

ROSTRARIA. A hardy, annual grass of the fescue tribe. It constitutes a genus of itself, and

takes the specific name of the pubescent; but it is classed by some botanists as a brome-grass, and by others as a cocksfoot. It commonly has a height of about a foot, and blooms from June till August; but it does not possess much economical interest. It was introduced to Britain about 28 years ago from the Continent.

ROT. A disease of the liver and the adjacent viscera of sheep. It is one of the oldest and most destructive of sheep-maladies; and has been supposed to destroy more sheep than all other maladies put together. It is known to have made great ravages for centuries; and though now less virulent in some districts than formerly, it still destroys many hundred thousands of sheep almost every year.

The rot has long been peculiarly rampant along the borders of the Nile in both Upper and Lower Egypt. "It assumes its most serious character," we are told, "after heavy rains and extensive floods, and in wet countries covered with aquatic plants. It affects animals of different ages, and in all seasons. It appears every year in Egypt after the fall of the Nile; and it follows and keeps pace with the subsidence of the waters. In the superior parts of Upper Egypt, it commences about the end of July; nearer Cairo, in August; in the environs of the capital, in October and November; and in the Delta, during the months of December, January, and February. It is most obstinate, and continues longest, in the neighbourhood of the confluence of the waters. In Lower Egypt, it lasts about 120 or 130 days; and it disappears soonest, and is least fatal, when the rise of the Nile has not been considerable. Desolation and death accompany it wherever it passes. The Arabs say that this pest annually destroys 16,000 sheep in Egypt. Its victims usually perish on the 25th, 30th, 35th, or 40th day after the apparent attack." It commits great havoc also in America and in Continental Europe; and it is far from being unknown even in the mild and comparatively dry and equable climate of Australia. In many a year, it has destroyed a million or so of sheep and lambs in Great Britain; and in 1830–31, it destroyed probably more than two millions,—carrying off some entire flocks, and so terribly reducing others as to bring their proprietors to bankruptcy.

Rot appears to be a morbid condition of the liver, either preceded or accompanied or immediately followed by the presence of flukes, and producing enlargement, inflammation, and speckling of the liver itself, and great and diversified disturbance, change, and injury of the neighbouring viscera. It is believed by some veterinarians to arise from the presence of flukes,—by others, from some one or more of several influences in vegetation, in the soil, or in the subsoil,—and by others, from a diversity or complication of causes. Flukes do not seem to be always present in its earliest detectable stages; and though always numerous in its later stages, and probably great accelerators of its progress, they seem rather to be a consequence of the disease than a cause. See the article Fluke. "The appearances exhibited in the sheep that has died of the rot," says Clater, "are very singular. There appears to be dropsy not only in the belly, but all over the animal. Whenever the knife is used, a yellow watery fluid runs out; and the consequence of the existence of this fluid everywhere is, that the muscles, and that which should be firm honest fat, are yielding and flabby and unwholesome. When the belly and chest are opened, the heart is pale and soft and flabby, and often to such a degree that we wonder how it could have continued to discharge its duty. The lungs are more or less gorged with blood; and there are a great many hard knotty points, of various sizes (tubercles), in them and on them, some of which have probably broken, and the lungs are full of ulcers; or when this is not the case, the lungs are studded with innumerable little knotty points of a dark colour. The principal disease, however, is in the liver, which is much enlarged, often of double its natural size, broken down by the slightest touch, sometimes black from inflammation and congested blood, and at other times of an unhealthy lividness; but that which is most remarkable, which is characteristic of the disease, is, that its vessels are filled with flukes, which are swimming about in the bile in every duct, and burrowing into every part of the liver." "In the quantity of tallow," says Hogg, "there is not much decrease, not near so much as the extreme debility before death would seem to announce. That which enwraps the stomach and kidneys, as well as the fat dispersed through the system, has lost its suety qualities, and become a tough yellowish-coloured substance, altogether infusible by heat; in some more, in some less, but always a quantity of serum loose in the abdomen, in which the bowels float. Over the carcass are sundry yellowish spots, which are not unfrequent where fat should exist."

The earliest symptoms of rot are exceedingly obscure, and sometimes cannot be detected till the disease has gone far to establish itself in a flock. Every farmer, especially in the districts which are most liable to it, ought to examine the liver of every sheep he kills for the use of his family; for he may by this means discover the existence of rot upon his farm long before it can be revealed by external symptoms, and may in consequence adopt early and effective means to stop its progress. Whenever the liver of a slaughtered sheep is dappled with white spots or contains some flukes within its bile, no matter how generally sound the carcase may otherwise be or how few and small may be the flukes, the flock may be regarded as already under the incipient influence of rot, and ought with all speed to be subjected to the requisite regimen for checking the disease. The earliest outward

symptoms are a dulness, a languor, and a partial loss of appetite which are common to other diseases, and might readily be mistaken for indications of light fever. A fattishness attends these which does not perceptibly differ from goodness of condition for the shambles, and which induced the celebrated Bakewell actually to subject his sheep for a few weeks to rotting influences as a preparation for the market, and which has been astutely seized by many a farmer as a crisis for profitably disposing of his sheep, when only a few days' delay might allow them to be prostrated and rendered unmarketable and brought into peril by the rot. The first distinctive symptoms are paleness of the membranes, pale yellowishness of the skin, a slight tinging of the mouth and lips, and a yellowness of the caruncle at the corner of the eye. A few weeks after, the sheep begin to shrink, and become flaccid about the loins, and acquire a paleness of countenance; and, at this stage, the skin has a pale red colour, the wool readily separates from the pelt, and, when the hips are pressed, they emit a perceptible crackling sound. At later periods, the skin becomes dappled with yellow and black, the mucous membranes become more pale, the eyelids become almost white and afterwards yellow, the dullness and the loss of condition increase, the yellowness of the eyelids extends to other parts of the body, the wool separates still more readily from the pelt, the skin becomes loose and flabby, a dropsical secretion forms under the skin and extends over the body, and sometimes a large swelling, popularly called the watery poke, forms under the jaw, and then the sheep is said to be 'chockered.' Hogg, when recording the results of his very extensive observation of the precursors and symptoms of rot, says that, when a sheep is becoming predisposed to it, from the effects of bad pasturage and perverted appetite, "the stomach and bowels increase to an extraordinary bulk, become an unmanageable weight, too weighty for the constituent parts to carry about with ease, or with that facility necessary to its thriving, and by degrees the animal assumes a bad shape, that is, the belly and hind quarters become heavy and lumpish, the fore quarters low, narrow, and contracted." And he adds, "The seeds of the disease may have struggled with the constitution for some seasons; but when the following external symptoms are exhibited, it is a plain declaration that all the ingredients necessary to constitute the rot are condensed and formed into disease, and that death will immediately ensue. I shall mention them in the order in which they generally appear. About the latter end of February or beginning of March, the wool loses its healthy brown colour, becomes bleached and dead-like; then follows considerable prostration of strength; late in leaving the tathy spots, and early on them next morning,—probably would not leave at all if not urged away by the shepherd; fall always back in the ranks when the shepherd moves them forward; a sullen, lustreless eye, looking steadily at the shepherd; an œdematous swelling under the chin,—this last is a late symptom."

The causes of rot assigned by veterinarians and experienced shepherds are numerous; and though some of them are fanciful, and others subordinate, most are worthy of consideration, and serve to indicate, if not the agencies, at least the circumstances and conditions, in which the disease originates.—One assigned cause is the extrusion of the ovules of flukes by rotted sheep, and the swallowing of these ovules by sound sheep; and though this erroneously regards flukes as preceding and exciting the disease, rather than as following and aggravating it, yet it instructively points out the fact of the coexistence of flukes and rot upon a farm, and suggests the imminent danger to which a whole flock are exposed whenever any flukes can be detected in any single sheep's carcase.—Another assigned cause is miasma, proceeding from the soil and entering the lungs; and though this is proved to be fanciful by the total absence in rot of the symptoms of intermittent fever, or low fever, or inflammatory action which accompany all truly miasmatic disorders, yet it usefully directs attention to marshy grounds, or grounds of a similar kind to marshy ones, as the sites of the true causes of the disease.—A third assigned cause is a certain noxious production of a particular kind of bog lands. "I do not think," says Mr. E. May of Berkshire, "that sheep become rotted from every kind of wet land, whether drained or not, but from a particular character of the soil and subsoil, such as is inclined to bog or quagmire, although it may not have that appearance on the surface of the land, but may lie 8 or 12 feet deep. Between this subterraneous bog and the surface there is generally a hard stratum of blue clay or sand, tainted with the bog-water lying underneath at that depth; and this infectious water is brought up from the bog to the surface of the earth by means of small pipes, which are always found to form the communication between them, and called by experienced land-drainers bog-pipes. In consequence of this infectious water thus arising to the surface, a plant is produced, not of the grass-tribe, but called by some old experienced shepherds 'the sheep-rot weed;' and if sheep are allowed to feed on this land, particularly if in a hungry state, although the weed does not grow more than an inch or two above the surface, and is of a nauseous taste, they will in this state of hunger indiscriminately eat it up along with the grass, and it will, I believe, more or less infect them with rot." This, however, as well as a number of similar alleged causes, is contradicted by the existence and ravages of rot in situations where no such alleged rot-exciting vegetation exists; yet it significantly points to deep, wet, boggy subsoils as a retreat of the true cause or causes

of the disease, and suggests the necessity of all sheep-pastures being moderately dry and duly aerated, not only within the range of ordinary artificial draining, but down to as great a depth of understrata as is likely to affect the exhalations and chemical actions of the surface.—A fourth assigned cause is superabundance of water taken into the system along with the food, or excess of liquid in the herbage of pastures, or a deficiency of firm, solid, and grateful properties in comparatively succulent herbage, surcharging the body with aqueous fluid, excessively diluting the blood, and provoking an over-secretion of serous juices. But though an excessive proportion of water in food may, in several respects, be injurious to the health of sheep, it does not seem of itself to be capable of producing rot; for sheep who, for a time, live entirely on turnips, take in no less than nine parts of water for every one part they receive of solid matter, and yet do not in consequence become rotted. Still the opinion that rot arises from succulency of herbage is entertained by many eminent veterinarians and very experienced shepherds; and, in spite of being essentially incorrect, it affords broad and valuable hints respecting the measures by which the true causes may be repressed. —Some other alleged causes are, too long indulgence on flat grassy pasture which has been recently flooded,—the breathing of exhalations from pastures which, though naturally dry, have been saturated with rains and then exposed to the play of ardent sunshine,—and driving rapidly or exhaustingly or through shady lanes or along diversified tracts from an upland to a lowland pasture; and all these, as well as some others, like the four at which we have distinctly glanced, either afford some indications of the true causes, or show the circumstances in which they operate, and suggest some means by which they may be counteracted.

The true causes are confessedly obscure; and probably will not be ascertained beyond debate for a long time to come. But one of the most undoubted of them—one, too, which goes far to explain the apparent force of most of the assigned causes we have named, and which gives both meaning and amplification to all the hints suggested by these respecting the best methods of prevention and cure—is a dead and fermenting state of herbage, or of portions of herbage, on any spot or expanse of sheep-walk, which suffers a high action from subterraneous exhalations, from concentrated manurial matter, from hottish stagnant water, or from the fierce or killing combination of moisture in the soil and heat in the atmosphere. No one author whom we are aware of points to this cause in the exact light or latitude in which we represent it; yet several of the most eminent assign to some one or more phases of it either main prominence or exclusive place. Spooner says: "It appears to me, that, in addition to the consumption of food in which water greatly abounds, it is essential that this food should be in a state of decomposition (partially rotten), in order to produce the rot. And this view of the case corresponds with the fact, that heat as well as moisture is necessary to cause rot, that it is not produced while the land is entirely under water, nor until the rays of the sun have acted on the grass previously saturated with moisture." Youatt says:—"The rot in sheep, is probably the produce of ground which has been lately wet, and then the surface exposed to the action of the air. The grass and other plants, previously weakened or destroyed by the moisture, become decomposed or rotten; and in that decomposition certain gases or miasmata may be developed that cannot long be breathed, or scarcely breathed at all, by the sheep without producing rot." Hogg says:—"Feeding on land which has been formerly or is at the time pastured by cattle, is an exciting cause of rot; and the rank grass of a deep green colour, springing from the spots on which they drop their dung, is likewise vastly deleterious; as is also that kind which rises round the borders of their foot marks, after being soaked with stagnant water. This last cause affects, not individuals, but whole parcels; and in general, any misfortune or slight disease which has for a while interrupted the animals thriving on all soft tathy pastures is almost sure of introducing the rot." And Clater says:—"Rot prevails, or rather is found only in boggy poachy ground. On upland pasture, with a light sandy soil, it is never seen; and in good sound pasture in a lower situation, it is only seen when, from an unusually wet season that pasture has become boggy and poachy. It is also proved to demonstration, that land that has been notoriously rotting ground, has been rendered perfectly sound and healthy by being well under drained, that is, by being made dry. There are hundreds of thousands of acres, on which a sheep, forty years ago, could not pasture for a day without becoming rotten, that are now as healthy as any in the kingdom. We can also tell the kind of wet ground, which will give the rot. Wherever the water will soon run off, there is no danger; but where it lies upon the surface of the ground, and slowly evaporates, the rot is certain. One part of a common shall be enclosed; or if it has not been drained, at least the hollows in which the water used to stand are filled up, and the surface is levelled; no rot is caught there. On the other side of the hedge there are these marshy places, these little stagnant ponds, where evaporation is always going forward, and the ground is never dry—a sheep cannot put his foot there without being rotted. These are plain palpable facts, and they are sufficient for the farmer's purpose, without his puzzling his brains about the manner in which wet ground produces diseased liver."

The prevention of the rot is of prodigiously more consequence than the cure, and must be

achieved by every method which will render the soil dry and the herbage sound. Whatever tends to improve the value of pasturage, and the general health of sheep, tends also to prevent the rot. Thorough-draining, the extirpation of weeds, the increase of the choicest grasses, the reclamation of all waste corners and boggy spots, the promotion of uniform cleanness and sweetness throughout all the area of a farm, the careful exclusion of sheep from every field and lane where they might be likely to encounter dead herbage or putrid puddles, and the keeping of cattle stock to eat all the aftermath of low and dangerous pastures, and to consume all esculent herbage anywhere which might be somewhat hazardous for sheep, are eminent preventives, and may be regarded as essential to success. Draining alone, without due regard to the drying of the deep subsoil and of every nook and square-yard of the ground, may not, in even the most favourable situations, be sufficient. A very little more than the average amount of rain upon heavy and tenacious land, no matter how regularly underlaid with ordinary drains, or only a few minutes' trampling upon some undrained or neglected nook of a field, all whose other area is perfectly dry and sound, may defeat very elaborate precautions, and give rise to very disastrous rot. "It is surprising," remarks Clater, "how soon the animal is infected. The merely going once to drink from a notedly dangerous pond has been sufficient,—the passing over one suspicious common in the way to or from the fair, and the lingering only for a few minutes in a deep and poachy lane. Then it can easily be conceived what mischief one or two of these neglected corners, in which there may be little swamps perhaps only a yard or two across, may do in a farm in other respects well-managed, and perfectly free from infection."

One of the best known means both of prevention after contact with infected ground and of cure in the early stages of the actual disease, is the use of common salt. This substance, besides promoting the general health of domesticated animals, and aiding the salubrious qualities of their sound food, both counteracts the putrefactive tendency of dead and fermenting herbage, and kills the eggs and the young of all such small animals as flukes. See the article Salt (Common). The natural presence of salt disarms wet pastures of all the power which they would otherwise possess to create the rot; and the artificial administration of it, regularly and judiciously along with food, protects sheep from danger in many an occasional situation or during many a critical season in which they might otherwise be overwhelmed with infection. "Salt-marshes, or low lands by the sea-side or on river-sides near the sea, which districts are alternately washed by high-tide sea-water and flooded with foul inland water charged with flukes' eggs, are proverbial sound sheep-walks. Situations which, further inland, would be regarded as the worst or most sure kind of rotting land, become, from being washed occasionally with sea-water, not only perfectly sound sheep-land, but are sometimes said to benefit animals already diseased. The salubrity of such situations is presumed to depend upon the action of sea-salt, of which a small deposit will be left upon the grass, as, after the subsidence of the last tide, the aqueous part of sea-water is evaporated by the wind and sun. Any small impregnation of iodine in the sea-water is not looked upon as operating in the case. It would seem, therefore, desirable to keep a moderate supply of common salt in the stomach of sheep, whilst and for a few days after they are using unsound or suspicious pasture. The practical herdsman would probably do well, when his flock may have accidentally or unavoidably grazed upon rotting land, to give his sheep an hour's run, twice or thrice a-day, upon acknowledged sound pasture of the most commingled herbage, that the animals may pick up some plant which stimulates their digestive organs. If he would improve upon this, he might give, with some prospect of advantage too, as often as twice or thrice a-day, a little barley meal, with chaff and salt, or good hay whetted with strong brine as food, or hay tea with salt for drink."

A cure is seldom effected when the disease has advanced far, but may be very hopefully attempted when the disease is only in an early stage, and especially when it is detected through the internal appearance of a killed sheep, and has not yet shown itself in any very perceptible external symptom. The infected flock should be removed either to a good salt marsh or to an artificially salted dry pasture. A piece of pasture, of sufficient extent to allow one acre to every ten sheep, may be hurdled off, and sprinkled equally with salt at the rate of one bushel for every sheep; and the flock may be turned into it about three weeks after the sprinkling, and may continue in it till they eat the grass quite close; and another piece of the same size, and similarly prepared, ought then to be ready for their reception. As much salt as they are disposed to take may be given also with their hay or their other food. An aperient of two ounces of Epsom salt in warm gruel or water must be given to each sheep at the commencement of the treatment, and should afterwards, at some distance of time, be once or twice repeated. Food of as nutritious a kind as convenient, such as a pint of beans daily, and a large allowance of good hay, and a quantity of good gruel, ought to be constantly allowed. Many kinds and combinations of medicine, comprising mercurials, balsams, essential oils, anodynes, tonics, aromatics, and miscellaneous drugs, have been recommended; but, for the most part, are either useless or positively objectionable. Calomel, at the rate of 4 grains or so a-day to each sheep, is confidently prescribed by some veterinarians, but pronounced

valueless or worse by others. A daily dose of half a drachm of sulphate of iron and the same quantity of powdered ginger in gruel, is one of the simplest and least objectionable of the prescribed aromatic tonics. A table-spoonful of oil of turpentine, mixed with two of water, and twice administered after an interval of 3 days, is said, in the Agricultural Report of Staffordshire, to have cured 5 out of 6 rotted sheep. And the following recipe is given by Mr. Clater, and is said by Henry Cleeve, Esq., to have been used with very salutary effects,—6 ounces of powdered saltpetre, 4 ounces of fresh powdered ginger, 2 ounces of finely powdered red oxide of iron, 3½ lbs. of common salt, and 3 gallons of boiling water,—the water to be poured on the other ingredients, the mixture stirred, 14 ounces of oil of turpentine to be added when the mixture becomes lukewarm, the whole to be now put into bottles, and three doses, of 4 table-spoonfuls each, to be given at intervals of four days to each sheep fasting.

Rotted sheep, however, no matter how slightly infected or how promptly cured, always retain a taint of the disease, and are peculiarly liable to be reinfected with it, and never attain restoration to complete vigour and perfect health, and, in many instances, fall victims, some 6 or 12 months after, to an attack of hoove or of intestinal inflammation. Lambs have occasionally been produced by cured ewes,—but they are feeble in constitution, and sickly in habit; and any sheep who have had rot, no matter how seemingly well recovered or how eventually high in condition, are readily known by a butcher, from the appearance of their liver, to have been diseased. Sheep-owners, therefore, will generally find it for their interest, not only to cure and fatten up infected sheep with all possible promptitude, but to sell them as soon as they are fattened.—*Spooner on the Diseases of Sheep.—Clater's Cattle Doctor.—Youatt on Sheep.—Mackenzie on Sheep.—Hogg's Shepherd's-Guide.—Prize Essay by H. Cleeve, Esq., in the Journal of the R. Agricultural Society of England.—Papers by Mr. Hogg and Mr. King in the Quarterly Journal of Agriculture.—The Veterinarian.*

ROT (Foot). See Footrot.

ROT (Scouring). See Dysentery.

ROTATION OF CROPS. The order in which different crops are made to succeed one another in the cultivation of any one field or plot. No kind of crop can be grown from year to year on the same ground without decreasing in productiveness; and every kind of crop is benefited by alternating with some other crop, and especially by constituting only one of a series of three or four or more. Different kinds are variously helpful to one another according to their classes, their habits, their secretions, their mode of cultivation, and the order of their succession; and both individuals and series of them have a great variety of adaptations to different soils and situations. A knowledge of rotations, therefore, is most important in the science of agriculture, and absolutely essential to its profitable practice. Though a farmer should know exactly what crops are best suited to his farm, and should understand how to manage each individual of them most successfully, yet unless he knew the proper order of succession in which to grow them, he might seriously injure them all, and could not possibly cultivate them to advantage.

A knowledge of rotations is one of the main differences between the barbarous husbandry of former periods and the improved husbandry of the present day. All the agricultural writers of Britain and of Continental Europe, down to the latter part of last century, spoke of the most deteriorating courses of cropping in the same terms in which they spake of the most ameliorating, and betrayed profound ignorance of the power of certain alternations and certain successions to improve the land and augment the aggregate produce; and hence, in spite of many valuable advances in the arts of tillage, in the construction of farm-implements, and in some of the great general principles of agricultural science, they were utterly unable to indicate to their readers any such broad and short path to an overflowing granary as lies open to all moderately skilful farmers of the present day. Arthur Young was one of the earliest agriculturists who tolerably understood this great subject; and he pushed and propagated it with all his characteristic enthusiasm, and put it on the foreground of a large proportion of his writings, and owed to the successful practice and inculcation of it a main part of his proud and well-earned fame. Many able writers followed him; thousands of the best farmers of England put his instructions to the test; the whole body of enlightened cultivators throughout all the good districts of Britain speedily heard of the doctrine of rotation and assented to its importance; and British agriculture, in consequence, suddenly acquired a greater accession to its prosperity than had ever before, even at the epoch of the drill husbandry, graced and enriched its history. "No one," remarks Philip Pusey, Esq., "would now think of growing, as formerly, wheat, barley, and oats in succession; and though Mr. Hitchins, land-surveyor of Brighton, states that, in his recollection, the tenants of a gentleman living in Sussex, when a clause was introduced into their leases prohibiting them from growing more than two white crops in succession, complained that they could not hope to defray their rents if fettered by such restrictions, few good farmers at present, on light soils at least, come even up to those limits, by raising even two white crops, as they are called, in immediate succession. It is on these light lands, indeed, that a due rotation of crops has so signally succeeded, that, whereas, they were formerly considered of very inferior value, they are now more readily occupied than those heavier

soils, which, being in their nature more suited to the growth of wheat, were once valued more highly. And it is as much by the slow and almost insensible amelioration of such land, as by any increased breadth of cultivation, that the country has become in any degree capable of supporting the vast numbers which have been added to her population. A small parish might be pointed out in which an aged farmer remembers the time when a single rick was all that it could produce of wheat in one year, whereas, without any increase of its ploughed ground, that same parish now yields five or six yearly. Its sandy soil was then drifted like snow before the wind, and the scanty barley might be sometimes seen borne away also; whereas, the very fields, still called 'the Sands,' are now, by that glutinous quality which high condition imparts—by the droppings and the tread of the sheep which are fed on the turnips that now grow in garden-like order where before was a naked fallow—compacted into a brown and adhesive, though still lightish loam."

Six general laws of vegetation, or six sorts of phenomena everywhere observable in the economy of plants, may be named and briefly illustrated as involving all the principles which originate and control an enlightened system of rotation of crops,—first, that all plants more or less exhaust the soil, and naturally possess appliances for shifting their ground upon their native habitats,—second, that all plants do not exhaust the soil in the same degree,—third, that plants of different families and different habits do not exhaust the soil in the same manner,—fourth, that all plants do not return to the soil either the same quantity or the same kind of manure,—fifth, that plants differ widely from one another in the encouragement they give to the growth of weeds which either smother useful vegetation or rob the soil of nourishment,—and sixth, that all cultivated plants, particularly such as are grown in large quantities in the fields, may be classified into exhausting and ameliorating, or into groups which are cultivable mainly on their own account, and groups which are cultivable partly or mainly for the sake of affording benefit to their successors, according to the predominant principles which they abstract from the soil, or according to the balance between the effects of their obstructing action and the effects of their excreting and manuring action. We shall devote a paragraph to the succinct discussion of each of these laws; and shall afterwards speak of the causes of the exhaustion of soil by plants, the practical principles which ought to regulate rotations, and the chief or most noticeable of the many kinds of rotation which are in use, in different districts and countries, on different kinds of land.

All plants, we have said, more or less exhaust the soil, and naturally possess appliances for shifting their ground upon their native habitats; so that when any of them are cultivated from year to year upon the same piece of land, they either degenerate more and more toward unproductiveness and sickliness and extinction, or they must, by means of rotations and manurings, be supplied artificially with advantages tantamount to those which they obtain by their natural migrations. All draw out of the soil some of the principles of their nourishment or some of the substances which form their organisms and secretions; and all more or less yield up some portion of these principles or substances to other spots by the expansion of their branches, by the dispersing action of winds, by the browsing of quadrupeds, by the picking of birds, and by other agencies; and just in the degree in which they do not eventually deposit any of these principles of their nutrition in the spot whence they derived them, they deprive that spot of power to produce or maintain a future race of plants of their own species, and also any other plants which feed on the same substances. All plants have naturally a power of migration proportionate, in the rapidity and extent of its action, to the speed with which they exhaust soils and the cravings they make for new sources of nourishment. Multitudes of herbs, both annual and perennial, belonging to many families, produce winged or downy seeds, and send off these on the gentlest breezes to germinate on distant grounds; and multitudes of trees and shrubs, of the most diversified constitution and opposite habits, produce their seeds within the substance of pleasant esculent fruits, and present these to birds and other animals to be carried away by them, and deposited in other places. All seeds, in fact, whatever be their particular economy, are not less storehouses of vitality, and compendiums of organic energy, than vehicles of vegetable migration. See the article SEED. But all plants, from the sturdiest and most stationary to the feeblest and most fugitive, also travel, or are locomotively reproductive, by means of some one or other organism which developes contemporaneously with either their own main growth, or their progress to maturity, or their advance toward decay. Many a tree, on finding the soil so deteriorated as to be incapable of any longer affording a due supply of nourishment to its young shoots and twigs, endeavours to escape from the spot on which it grows by sending up side-suckers which may push their individual roots beyond the sphere of the deteriorated soil. Either a tree or a shrub, so long as it is young, healthy, vigorous, and fully fed, remains steadily in its original site, entirely enjoying the riches of the subjacent soil, and making not the remotest effort to migrate otherwise than by its seed; but when it becomes old or stunted or ill-fed, whether it be an ancient plum or pear tree in the orchard, or a decaying currant or gooseberry bush in the garden, or a starved rose-bush on the flower-border, or any other kind of lig-

neous plant in any situation whatever, it strives to send up as many or as distant suckers as will correspond to the degree in which the immediate soil has become exhausted; and, in general, whatever be its species, it makes this kind of effort, at an earlier or later period of its existence and in a lesser or greater amount of strength, proportionately to its voracity for some of the rarer principles of the soil, and to the presence or absence, the abundance or the paucity, of its making migrations by means of seeding. Similar remarks might be made, with far more force, respecting the rhizomas, the bulbs, the tubers, the offsets, the runners, and the stolons of herbaceous plants; but are, in many instances, so obvious and striking, that they will spontaneously occur to any ordinarily attentive observer. Strawberries and potatoes may be quoted as familiar examples. "And these," remarks Sir Humphrey Davy, "at first produce luxuriantly in virgin mould recently turned up from pasture; but in a few years they degenerate, and require a fresh soil, and their organization is such, as to be constantly producing the migration of their layers. Thus the strawberry by its long shoots is constantly endeavouring to occupy a new soil; and the fibrous radicles of the potato produce bulbs at a considerable distance from the parent plant. Lands in a course of years," he continues, "often cease to afford good cultivated grasses; they become, as it is popularly said, tired of them. The most remarkable instance of the powers of vegetables to exhaust the soil of certain principles necessary to their growth is found in certain funguses. Mushrooms are said never to rise in two successive seasons on the same spot, and the production of the phenomena called fairy rings has been ascribed by Dr. Wollaston to the power of the peculiar fungus which forms it, to exhaust the soil of the nutriment necessary for the growth of the species. The consequence is, that the ring annually extends, for no seeds will grow where their parents grew before them, and the interior part of the circle has been exhausted by preceding crops; but where the fungus has died, nourishment is supplied for grass, which usually rises within the circle, coarse, and of a dark green colour."

All plants do not exhaust the soil in the same degree. Though all are nourished by air, water, and the juices of the soil; yet they differ widely from one another in the quantity of the last of these which they abstract. Some require to have their roots constantly immersed in water, some require a sandy and arid situation, and some thrive only in rich, loamy, high-manured soils; and no two of these and other great classes, or even of many subordinate ones, agree in the amount of their dependence on the soil for supplies of air and moisture, and especially in the proportion of saline ingredients which they withdraw from land. "The cereal plants and most of the grasses," remarks Chaptal, "throw up long stems, consisting chiefly of fibrous matter; and these are furnished at their foot with a few leaves, which, on account of the compactness of their texture, and the small surface which they present, can absorb, comparatively, but little either of air or water. These plants therefore derive their nourishment principally from the soil, and their stalks are employed either for litter or food for animals; so that while they greatly exhaust the soil, they return scarcely anything to it,—their stalks being cut and taken away from the ground for the purposes just mentioned, and their roots, which alone remain, being dried up and drained of all their juices, in the process of forming and of maturing the seed. Plants, on the contrary, abundantly furnished with large, thick, porous leaves, that are constantly green, imbibe from the atmosphere carbonic acid and oxygen, and draw from the earth such other substances as they require for their nourishment. When plants of this kind are cut in a green state, the loss of nutritive juices sustained by the soil is less sensibly felt, inasmuch as these are in part given back to it by the roots. Such plants as are usually cultivated for fodder are nearly all of this description. There is another class of plants, which, though cultivated principally for their seed, are less exhausting to the soil than the cereal plants; we refer to the numerous family of legumes, which holds an intermediate place between the two classes of which we have just spoken. The long perpendicular roots of the leguminous plants divide the soil, and their large leaves, and thick, soft, spongy stems, readily absorb both air and water. The different parts retain for a long time the juices with which they are so abundantly impregnated, and give them back to the soil, when the plants are ploughed in at a period before they become mature; and by this means alone, the soil may be put in a condition to produce a good crop of grain. Beans are particularly valuable in this respect; while vetches and pease, and more especially the latter, are less fertilizing in their effects. Generally speaking, if plants be cut in a green state, and at the time they are in flower, whatever may be their particular nature, they do not exhaust the soil; since up to this period they have drawn their nourishment almost exclusively from the earth, air, and water. Both their stalks and roots abound in juices, and the parts remaining after the former are cut, return to the soil all that has been taken from it for the support of the plants. But as soon as the seed once begins to form, the process of nutrition undergoes a change. The plant, as before, still abstracts nutritive principles from the earth and atmosphere; but in addition to this, it now resorts to the juices contained in its stalks and roots, and these likewise are made to contribute to the formation of the seed; so that, from this time, the stalks and roots are both gradually dried up and exhausted; and when at

length the seed has reached maturity, the skeleton merely of the plant remains, and this, on being given back to the soil, returns to it but a very inconsiderable portion of what it had previously taken from it." Different groups of species, too, abstract different inorganic principles from the soil; and in proportion to the general rareness of any peculiar principles which some species abstract, or to the comparative voracity with which they abstract them, these species are exhausting. Some of the rarer principles, likewise, particularly the phosphatic and the nitrogenous, are far more plentifully abstracted from the soil by the seeds of any plants, especially by those of the cereal grasses, than by any or sometimes all of the previously formed organisms; so that the exhaustion during the formation and maturing of seeds is often greater from this cause than even from the seminal exsiccation of the stems and roots,—and the aggregate amount of exhaustion caused by any particular species of plants, as compared to that caused by any other species, may, in general, be pretty closely estimated by the proportion of these principles in the seeds. This topic, however, will be resumed and followed out in a subsequent paragraph, on the sixth and last of the general laws which explain the system of rotations.

Plants of different families and different habits do not exhaust the soil in the same manner of pasturing within it, or of exploring and diminishing its magazines of nourishment. "The roots of plants of the same family," observes Chaptal, "extend themselves in a similar manner, penetrating to the same depth, growing of the same length, and exhausting all that portion of the soil which they encompass, or with which they come in contact. Such roots as run nearest the surface, and occupy the least space, are the most divided. Perpendicular roots that penetrate far into the earth, throw out but few radicles near the surface, and draw their nourishment from a considerable depth. If in transplanting a turnip or beet, the point of the taproot be cut off, so that it can no longer run down into the soil for nourishment, it will send out small fibrous roots from all parts of its surface, which extending to a certain distance, absorb the nutritive principles from such portions of the soil as they are able to reach; and in this case the form of the root will be roundish instead of being tapering and long. It would appear, then, that the roots of plants exhaust only such portions of the soil as are in contact with them; and thus long perpendicular roots may be enabled to obtain from a soil abundant nourishment, even when its upper portion has been completely exhausted by such as naturally run near the surface. The roots of plants of the same species, and of such also as are of analogous character, uniformly extend themselves in a similar direction, whenever the character of the soil prevents not their free development; so that they all occupy the same stratum of earth, and are nourished by it. Hence it is that trees rarely flourish when, in the same ground, they are made to succeed others of the same species; and especially when sufficient time has not intervened for the roots of the first to decay, so as to afford to the stratum of soil occupied by them a fresh supply of manure."

All plants do not return to the soil either the same quantity or the same kind of manure. "All more or less exhaust the soil of its nutritive juices; but, on the other hand, they all likewise restore to it, in the remains they leave behind them, something in a degree to repair this loss. The cereal and oleaginous plants are the most exhausting of all, and at the same time return the least to the soil. When plants, in being gathered, are pulled up with their roots, they do not leave anything to repay for the nourishment which they have received. It is true that other kinds of plants consume, in seeding, a large proportion of the manure which is contained in the soil; but then the roots of a part of these penetrate far into the soil, separate its parts, and render it loose and open to a great depth; while others, again, cover its surface with their numerous leaves, and these being detached from their stalks during the progress of vegetation, compensate in part for what has been taken from it. There are some plants, also, the stalks and roots of which still retain their succulence even after their fruit is matured; and which, therefore, in their decomposition, restore to the soil a portion of the juices of which they had deprived it; certain of the legumes are of this character." The residuary matter after harvesting, whether in the form of roots, stubble, radical leaves, fallen stems or shed seeds, is of still greater importance. "It is a point of interest," remarks Boussingault, "to ascertain what quantity of elementary matter is left in the soil after each kind of crop in the rotation. Precise knowledge of this description may even be important in calculating rotations; for it is obvious that the remains of the crop now on the ground must influence that which is to follow, and in the course of a rotation the sum of the residuary matters must be regarded as a supplement or addition to the manure put into the ground at its commencement. In the systems of rotation very generally followed at the present time, the influence of these residuary matters is manifest, and it is partly by their means that we can explain how a quantity of manure, frequently very moderate, should suffice for the whole of the crops in a productive rotation. All the world acknowledge that the residues of crops compensate in greater or less degree for what is carried away in the shape of harvest, and that in some cases they even add to the fertility of the soil; for in growing crops that leave a large quantity of residue, it is precisely as if a smaller quantity were taken

from a given extent of surface. But what is the amount of residue or refuse which is returned to the soil by such and such a crop? What, in a word, is the value of this residuary matter considered as manure? This is a point upon which only the most vague and indefinite ideas are generally entertained; and it was with the purpose of substituting positive facts for mere guesses that I determined on weighing and analysing the vegetable residue of the several crops that enter as elements into our more usual rotations. My experiments were made upon breadths of land which varied from 120 to 500 square yards in extent. The clover roots and stubble were taken up with the spade, and before being dried, were freed from adhering earth by washing. The beet-leaves and potato-tops were dried at once in the oven; and it was from each the general mass reduced to powder that samples were taken for ultimate analysis, before proceeding to which, they were carefully dried in vacuo at 230° F. In the following table is a summary of the results, together with the quantity and the composition of the manure expended in the rotation.

Nature of the crop.	Produce per acre in 1839.	Produce dried at 212 degrees F.	Nature of the residues buried in the soil.	Residues obtained upon one acre.	Residues dried at 230° F.	Elementary matter of the residues.				
						Carbon.	Hydrogen.	Oxygen.	Azote.	Salts and earths.
	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potatoes	11367	2739	Potato tops	2632	630	282	32	189	14	112
Beetroots	13678	1668	Beetroot leaves	9599	1070	410	55	330	48	236
Wheat	2150	1837	Stubble	1283	950	460	50	369	4	67
Clover-hay	2292	1810	Roots dried in the sun	1833	1418	615	75	523	26	178
Oats	1862	1474	Stubble	836	596	299	32	232	2	30
Total	31349	9527		16182	4664	2066	244	1643	94	617
Manure employed	44995				9314	3335	391	2403	186	2995

It, therefore, appears that the refuse or residue of the several crops of a rotation represent both in quantity and in nature somewhat less than one-half of the manure originally put into the ground; I say somewhat less, because it must be remembered that in the sum of these residuary matters, the beetroot leaves and potato tops must not be allowed to stand together, the one crop naturally excluding the other, or at all events the two hoed or drill crops not entering in this proportion into the same rotation. The large quantity of organic matter restored to the soil by several of the crops in the series, consequently explains how the rotation may be closed without its being found indispensable to supply any additional manure in its course." Plants also differ widely from one another in the kind and amount of excrementitious matter which they deposit in the soil; and, for the most part, each species excretes substances which are more or less injurious to the growth of other individuals of its own species or genus, and at the same time more or less beneficial to the growth of individuals of some other species. See the article Excretion of Plants. The same species, likewise, according to the manner in which a crop of it is treated or disposed of, may differ very widely from itself as to both the kind and the amount of the manurial matter which it deposits. Many a crop which naturally exercises a very exhausting action, may be so treated as to return to the soil everything which it abstracted, or even to impart to it much additional fertilizing matter, or even to prove the occasion of depositing upon it a comparatively vast amount of very enriching manure. All crops ploughed in as green manure, and all which are allowed to decay entirely where they grow, and especially all which are fed off where they stand by sheep or other live stock, are of this class. See the articles Green Manures, Fallow, and Fold. Some of the ordinary crops of the farm, too, are mightily controlled in their power of either exhausting the soil or manuring it by the stage of growth at which they are cut down, and the degree in which their reaped produce is eventually restored or not restored to the ground. "When a herbaceous plant," remarks Professor Low, "is suffered to mature its seeds, and when any part of these seeds is carried off the farm, the plant affords, when consumed by animals, a smaller return of manure to the farm than if the same plant had been cut down before it had matured its seeds, and been in that state consumed by animals. Thus it is with the turnip. This plant is with us sown before midsummer. In the first season, it forms a napiform root, and puts forth a large system of leaves. Early in the following season, it puts forth a long stem, which bears flowers, and the seeds are generally matured about midsummer. If this plant is removed in the first stage of its growth, that is, after it has put forth its large leaves and formed its bulb, and is then consumed by animals, it returns a great quantity of manure; but if it remains until the second stage of its growth, then the consumption of its stem and leaves returns scarce any manure. The juices of the root have apparently been exhausted in affording nutrition to the flower-stem, the flowers, and the seeds. It is beyond a question, that, in order to bring a plant to its entire maturity, by the perfecting of

its seeds, a larger quantity of the nutritive matter of the soil is sucked up by it than when it is brought only to its less advanced stages. When crops of plants, therefore, are suffered to arrive at maturity, they are greatly more exhausters of the soil on which they grow than when they are cut down while they are green; and if those seeds are in whole or in part carried off the farm, the crops are exhausters of the farm, as well as of the ground which had produced them. Were the ripened seeds to be wholly returned to the soil, it may be believed that they might give back to it all the nutritive matter which had been derived from it. But, in practice, seeds are employed for many purposes, and are generally carried off the farm which produces them. When this is done in whole or in part, the plants produced are in an eminent degree exhausters of the farm, as well as of the soil on which they have grown."

Plants differ widely from one another in the encouragement they give to the growth of weeds which either smother useful vegetation or rob the soil of nourishment. "The cereal plants take precedence of all others in this respect; since their tall, slender stalks, and long, narrow leaves but very partially shade the ground, and thus not only permit such weeds as are natural to the soil to spring up in their intervals, but also encourage their growth by the protection which they afford to them against the heat and winds. Herbaceous plants, on the other hand, their stalks rising only to a moderate height, and their leaves covering the entire surface of the soil, effectually prevent the growth of everything about their roots, and consequently the soil is kept clean, and free from weeds. It must, however, be remarked, that this latter effect will only be produced, where the soil is suited to the growth of the plants, and at the same time abundantly supplied with manure, so that there shall be a luxuriant and vigorous vegetation; since, in cases where these favourable circumstances do not exist, we shall observe the same plants to be in a feeble and languishing condition, so that they become gradually overshadowed by others of a more sturdy and less useful character, until at length they are entirely displaced by them. When plants are cultivated in furrows, as is the case with roots and most of the legumes, large intervals are left which become occupied by weeds; the soil however may be kept clean in this kind of culture, by frequently passing over it with the hoe, or with some other suitable implement; and it may in this way be maintained in a state sufficiently fertile to produce another crop, especially if the plants growing upon it be not suffered to mature their seed. The seeds of weeds are often mixed with those of the useful plants, and sown at the same time; nor can the farmer be too careful in avoiding this. But much more frequently these seeds are conveyed by the winds, or deposited by water, or committed to the soil along with the manure."

All cultivated plants, particularly such as are grown in large quantities in the fields, may be classified into comparative exhausters or comparative ameliorators according to the predominant principles which they abstract from the soil. "Different genera of plants," remarks Liebig, "require for their growth and perfect maturity either the same inorganic means of nourishment, although in unequal quantities and at different times, or they require different mineral ingredients. It is owing to the difference of the food necessary for the growth of plants, and which must be furnished by the soil, that different kinds of plants exert mutual injury when growing together, and that others, on the contrary, grow together with luxuriance. Very little difference is observed in the composition of the ashes of the same plants, even although they have grown on different soils. Silica and potash form invariable constituents in the straw of the Gramineæ; and, in their seeds, there are always present phosphate of potash and phosphate of magnesia. A large quantity of lime occurs in the straw of pease and in clover. We know, further, that in certain kinds of plants, the potash is replaced by soda, and the lime by magnesia. It has been shown by the experiments of Boussingault, that the five following crops grow in succession on an equal surface of the same field once manured, removed from the soil:—

	Ingredients of the soil. Lbs.
1 Year crop of potatoes (tubers without herb)	246·8
2 " " Wheat (straw and corn)	371·0
3 " " Clover	620·0
4 " " Wheat / Fallow Turnips	488·0 / 108·8
5 " " Oats (corn and straw)	215·0
By a crop of Beetroot (roots without leaves)	399·6
" " Pease (pease and straw)	618·0
" " Rye	284·6
" " Helianthus tuberosus	660·0

These numbers express the quantities of inorganic substances removed from the same soil by different plants, and carried away with the crops. They, therefore, prove that different plants take up into their organism unequal weights of these ingredients of the soil. It is shown by a further consideration of the composition of these ashes, that they differ essentially from each other with respect to their quality. One thousand parts of beet, turnips, or potatoes, yield by incineration 90 parts of ashes; the latter are easily fusible, and contain a large quantity of carbonate of potash, and of salts with alkaline bases. Of these 90 parts, 75 parts are soluble in cold water. Two thousand parts of dry fern yield also 90 parts of ashes; but of these 90 parts none, or only a trace, is soluble in water. The ashes of wheat, barley, pea and bean straw, differ in like manner in their composition. Equal quantities of their ashes contain very unequal amounts of ingredi-

ents soluble in water. There are certain ashes of plants wholly soluble in water; others are only partially soluble; while certain kinds yield only traces of soluble ingredients. When the parts of the ashes insoluble in water are treated with an acid (muriatic acid), this residue, in the case of many plants, is quite soluble in the acids (as for instance the ashes of beet, turnips, and potatoes); with other plants, only half the residue dissolves, the other half resisting the solvent action of the acid; while in the case of certain plants only a third or even less of the residue is taken up by the acid. The parts of the ashes soluble in cold water consist entirely of salts with alkaline bases (potash and soda). The ingredients soluble in acids are salts of lime and magnesia; and the residue insoluble in acids consists of silica. These ingredients being so different in their behaviour to water and to acids, afford us a means of classing the cultivated plants according to their unequal quantity of these constituents. Thus potash plants are those the ashes of which contain more than half their weight of soluble alkaline salts; and we may designate as lime plants and as silica plants, those in which lime and silica respectively predominate. The ingredients thus indicated are those which form the distinguishing characteristics of the plants which require an abundant supply of them for their growth. The potash plants include the chenopodia, arrach, wormwood, &c.; and amongst cultivated plants, the beet, mangel-wurzel, turnip, and maize. The lime plants comprehend the lichens (containing oxalate of lime), the cactus (containing crystallised tartrate of lime), clover, beans, pease, and tobacco. Silica plants include wheat, oats, rye, and barley.

		Salts of Potash and Soda.	Salts of Lime and Magnesia.	Silica.
Silica Plants.	Oat-straw with seeds	34·00	4·00	62·00
	Wheat-straw	22·00	7·20	61·05
	Barley-straw with seeds	19 00	25·70	55 03
	Rye-straw	18·65	16·52	63·89
Lime Plants.	Tobacco (Havannah)	24·34	67·44	8·30
	" (Dutch)	23·07	62·23	15·25
	" (grown in an artificial soil)	29·00	59·00	12·00
	Pea-straw	27·82	63·74	7·81
	Potato-herb	4·20	59·40	36·40
	Meadow-clover	39 20	56·00	4·90
Potash Plants.	Maize-straw	71·00	6·50	18·00
	Turnips	81·60	18·40	
	Beetroot	88·00	12·00	
	Potatoes (tubers)	85·81	14·19	
	Helianthus tuberosus	84·30	15·70	

This classification, however, is obviously only a very general one, and permits division into a great number of subordinate classes; particularly with respect to those plants in which the alkalies may be replaced by lime and magnesia. The potato plant belongs to the lime plants, as far as regards the ingredients of its leaves; but its tubers (which contain only traces of lime) belong to the class of potash plants. With reference to the silicious plants, this difference of their parts is very marked. Barley must be viewed as a lime plant, when compared with oats or with wheat, in reference to their ingredients soluble in muriatic acid; but it would be considered as a silicious plant, if viewed only in reference to its amount of silica. Beet-root contains phosphate of magnesia, and only traces of lime; while the turnip contains phosphate of lime, and only traces of magnesia. When we take into consideration the quantity of ashes, and their known composition, we are enabled to calculate with ease, not only the particular ingredients removed from a soil, but also the degree in which it is exhausted of these by certain species of plants belonging to the potash, lime, or silicious plants. This will be rendered obvious by the following examples. A soil, consisting of four Hessian acres, has removed from it by a crop of—

		Salts of potash and soda.		Salts of lime, magnesia, and peroxide of iron.		Silica.
		lbs.	lbs.	lbs.	lbs.	lbs.
Wheat	In straw	95·31	130·51	34·75	67·55	260·05
	In corn	35·20		32·80		
Pease	In straw	154·40	198·42	354·80	371·46	46·60
	In corn	44·02		16·68		
Rye	In straw	40·73	82·78	36 00	57·82	139 77
	In corn	42·05		21·82		
Beetroot, without leaves,			361·00		37 84	
Helianthus tuberosus			556·00		104 00	

The same surface is deprived by these crops of the following quantity of phosphates:—

Pease.	Wheat.	Rye.	Helianthus Tuberosus.	Turnips.
117	112·43	77·05	122	37·84

* * * In a soil rich in alkaline silicates, but containing only a limited supply of phosphates, the period of its exhaustion for these salts will be delayed if we alternate with the wheat plants which we cut before they have come to seed; or, what is the same thing, with plants that remove from the soil only a small quantity of phosphates. If we cultivate on this soil pease or beans, these plants will leave after the removal of the crop, a quantity of silica in a soluble state sufficient for a succeeding crop of wheat; but they will exhaust the soil of phosphates quite as much as wheat itself, because the seeds of both require for their maturity nearly an equal quantity of these salts. We are enabled to delay the period of exhaustion of a soil of phosphates by adopting a rotation, in which potatoes, tobacco, or clover, are made to alternate with a white crop. The seeds of the plants now named are small, and contain proportionally only minute quantities of phosphates; their roots and leaves, also, do not require much of these salts for their maturity. But it must be remembered, at the same time, that each of these have rendered the soil poorer by a certain quantity of phosphates. By the rotation adopted, we have deferred the period of exhaustion, and have obtained in the crops a greater weight of sugar, starch, &c., but we have not acquired any larger quantity of the constituents of the blood, or of the only substances

which can be considered as properly the nutritious parts of plants. * * * If a field on which a rotation of cultivated plants has been carried on for a series of years contain an ordinary proportion of alkaline silicates, clay, lime, and magnesia, it will possess an almost inexhaustible provision of alkalies, alkaline earths, and silica; with this difference, however, that they are not all in a fit state to be used by the plant at the same time. By the mechanical operations of the farm, and by chemical means (by the use of lime, &c.), we may shorten the time in which these obtain a form fitted for the vital functions of the plant; but these matters do not suffice for its complete maturity. When phosphates and sulphates are absent from the soil, the plants growing on it cannot form seeds, because all seeds, without exception, contain compounds in which phosphoric acid and sulphur are invariable constituents. Although all the other ingredients of plants be present in superabundance, the soil will become completely sterile, when the period arrives at which it can no longer furnish phosphates or sulphates to a new vegetation. We must suppose that, for the formation of the stem and herb, for the fixation of carbon, and for the production of sugar, starch, and woody fibre, a certain amount of alkalies (in the case of the potash-plants), or an equivalent of lime (in the case of the lime plants) is necessary. But we must bear in mind, at the same time, that the constituents of blood can be formed in the organism of the plant only in quantity corresponding to that of the phosphates, however abundantly ammonia or carbonic acid may be supplied. The production of the constituents of the juice containing sulphur and nitrogen is inseparably connected with the presence of these salts. Every soil upon which a weed attains maturity is fitted for culture if that weed yields, on incineration, alkaline ashes. The alkalies of these ashes arise from silicates, so that in addition to the alkalies, soluble silica must exist in the same soil. Such a soil may contain a quantity of phosphates of lime and magnesia sufficient for potatoes and turnips, without on that account being rich enough for crops of wheat. These considerations must show the great importance which ought to be attached to phosphates in the practice of agriculture. These salts are present in the soil only in small quantity, and therefore the greater attention should be paid to prevent its exhaustion.

* * * "It follows, then, from the preceding observations, that the advantage of the alternate system of husbandry consists in the fact, that the cultivated plants abstract from the soil unequal quantities of certain nutritious matters. A fertile soil must contain in sufficient quantity, and in a form adapted for assimilation, all the inorganic materials indispensable for the growth of plants. A field artificially prepared for culture, contains a certain amount of these ingredients, and also of ammoniacal salts and decaying vegetable matter. The system of rotation adopted on such a field is, that a potash-plant (turnips or potatoes) is succeeded by a silica plant, and the latter is followed by a lime-plant. All these plants require phosphates and alkalies —the potash-plant requiring the largest quantity of the latter and the smallest quantity of the former. The silica plants require, in addition to the soluble silica left by the potash plants, a considerable amount of phosphates; and the succeeding lime plants (pease or clover) are capable of exhausting the soil of this important ingredient to such an extent, that there is only sufficient left to enable a crop of oats or of rye to form their seeds. The number of crops which may be obtained from the soil depends upon the quantity of the phosphates, of the alkalies, or of lime, and the salts of magnesia existing in it. The existing provision may suffice for two successive crops of a potash or of a lime plant, or for three or for more crops of a silica plant, or it may suffice for five or seven crops of all taken together; but after this time, all the mineral substances removed from the field in the form of fruit, herbs, or straw, must again be returned to it; the equilibrium must be restored if we desire to retain the field in its original state of fertility."

The causes of the exhaustion of soil by plants, or the natural agencies which render a constant rotation of crops in farm cultivation essential to profitable management, are so obvious from the six general laws of vegetation which have been illustrated in the six preceding paragraphs, that they scarcely need to be mentioned. One is the natural dispersion, partly by the plants themselves and mainly by birds and land animals who feed upon them, of some of the saline principles which all nutrimental plants more or less freely abstract from the soil. Another is the rapid removal from the farm, in the form of seeds and of the carcases of live stock, both of the scarcest and most valuable of the saline principles which are naturally contained in the soil, and of all the essential and most characteristic principles which are artificially supplied, from time to time, in the form of manure. A third is the removal from one field to another, or sometimes the removal from all the arable area of the farm, of such portions of the principles of nutrition as are abstracted by weeds. A fourth is the difference of range and depth in the cubic space which the roots of different plants occupy during the progress of their development and growth. A fifth is the diversity of inorganic food appropriated by different groups of cultivated plants,—such that when a field has lost the materials for feeding one group, it still possesses those for feeding another, and when it has lost the materials for feeding a second, it still possesses those for feeding a third. A sixth is the very different amount and composition and value of the residuary

matter which the different cultivated crops contribute to the ground at the time of their being mown or pulled or otherwise reaped or gathered. A seventh is the singular and exceedingly varied character and action of the excrementitious matter deposited by crops,—that of any one crop being fitted to injure a succeeding crop of the same or similar kind, and yet to benefit a properly selected succeeding crop of a different kind. An eighth is the tendency of any one crop, when repeated, to encourage the ruinous prolificity of such insects as prey upon its roots and stems, and such cryptogams as send up their sporules from the soil to feed upon its organisms,—and the contrary tendency of each of the different crops of a series to starve out all the insects and cryptogams which prey upon the others. And a ninth is the mighty facilities which are afforded by alternations of widely different kinds of crops so to modify and regulate their adaptations to one another, and their individual treatment, and the methods of disposing of them, as to control or retard or counteract any or all of the exhausting processes of a rotation by concurrent or alternate ameliorating processes.

The practical rules which ought to regulate rotations are easily deducible from what we have said, and do not require any separate proof or illustration. Some of the most obvious and important of them are, that plants which have long perpendicular roots should succeed those which have spreading and superficial roots,—that crops of the same or similar species of plants should not follow in succession, but should return at as distant intervals as shall be found to comport with general convenience and profit,—that two kinds of crops which alike or similarly encourage the growth of weeds should not follow in succession,—that crops which abstract phosphates and sulphates and nitrogenous principles from the soil, and secrete them in seeds or other forms which are not returned again to the field, should alternate with crops and with methods of treating and consuming them which shall not carry away but rather augment the remainder of these salts and principles in the soil,—that, on every farm which has been long under cultivation, crops which require much of either these or other scarce and valuable principles shall be raised only on soil which has been recently enriched with them by means of artificial manurings, and shall be followed or alternated, at sufficiently short intervals, with either crops or fallowings which shall give back to the soil as much of the rare salts and principles as they have abstracted,—that the several members of a rotation should follow one another in an order of succession studiously adapted to the conditions and changes of the soil in the successive years after fallowing or special manuring,—and that the laying down of land to grass, in a system of alternating lea with tillage, should be done when the soil is both clean and fertile. The cereal grasses, wheat, barley, oats, and rye, as grown for the maturing and carrying away of their seeds, are the greatest exhausters; the pulse plants, the pea and the bean, as grown for the maturing and carrying away of their seeds, are exhausters of less severity than the cereal grasses, and afford considerable compensatory action by means of their succulent roots and of the horse-hoe method of culture; the fibre-yielding and oleaginous plants, flax and hemp, are either exceedingly slight exhausters when pulled in flower and made to contribute only their fibre, but exceedingly severe exhausters when grown to maturity and made to contribute the entire substance of their seeds; and either the turnip, the rape, and other brassicas, when raised only for their roots and leaves, and consumed upon the farm,—or the beet, the parsnip, the carrot, the potato, and other plants of similar habit, when raised only for their roots and tubers and consumed upon the farm,—or the clover, the tare, the lucern, and other forage leguminous plants, when cut green or in flower and consumed upon the farm, are more or less non-exhausters in the ordinary method of cultivating them, and can, in most instances, be rendered powerful ameliorators either by special modes of consuming them on the ground, or by sending back to the soil the putrescent rejectamenta of their eaten produce in combination with the litter of the farm-yard. Or, to make another practical classification, the cereal crops are exhausting and befouling; the horse-hoed pulse crops are exhausting and cleaning; the green forage crops are ameliorating and sometimes befouling; the green fallow crops are ameliorating and cleaning; and the sown grass crops, continued into lea, are ameliorating and capable of being made most thoroughly cleaning.

All particular rotations, however, whether for an entire farm of homogeneous character, or for coadjacent fields of diversified character, ought to be determined with due reference to soils, local circumstances, and market profits. "Lucern and sainfoin," remarks Chaptal, "are classed among the plants which should have a place in the system of a rotation of crops; nevertheless, it is to be remembered that these plants require a deep soil, and at the same time not too compact, in order that they may freely penetrate the earth with their long perpendicular roots. Hemp, flax, and the cereal plants, require good ground, and should not be admitted into a course of crops, except in such soils as are abundantly fertile and thoroughly prepared. Light, dry soils are unsuited to the same succession of plants, as would be appropriate to those of a compact nature, and which are constantly humid. Each kind of soil, therefore, demands a particular course of crops; and every agriculturist should arrange his system according to the nature and properties of the soil which he has to cultivate. Inasmuch as in each different situation, soils will present some shades of dissimilarity, more or less

distinctly marked, according to their exposure, depth, composition, &c., the farmer should vary his cultivation in conformity to these differences, and adopt for each kind of soil the course of crops to which it is best suited. The wants of his own particular locality, the greater or less facility in getting his products to market, and the relative value of different crops, should also influence him in forming his plans of cultivation. In England, and in some of the northern countries of continental Europe, barley is made frequently to recur in a course of crops, for the reason that in these countries there is a sure and constant demand for this kind of grain, to supply their numerous breweries. In Belgium, on the borders of the Rhine, and in Russia, rye is very extensively cultivated, since the immense distilleries in these countries, and the feeding of a multitude of animals upon the remains of the grain, and other refuse matter furnished by these establishments, secure to it a certain and profitable sale. The culture, again, of plants made use of for the colouring matter which they contain, as woad and madder, is more advantageous in the neighbourhood of large dyeing establishments, than in countries where there is no consumption of these articles. In France, where the abundance and the low prices of wine hold out no prospect of an extensive demand for malt liquors, and where most of the people are accustomed to live chiefly upon bread made of wheat, this particular grain is cultivated in preference wherever it can be made to grow, while only the inferior soils are appropriated to the other kinds. There is still another consideration which should be well weighed by the farmer, before he decides upon his course of crops; and that is, that although his soil may be well adapted to a particular culture, his interest may, nevertheless, be opposed to the pursuit of it. The more abundant a commodity is, the more reduced it will be in price; and those articles should always be cultivated in preference, which will command the readiest sale, and afford the most remunerating returns. When, too, any product is not expected to be consumed upon the spot, the expense of its transportation to a market must be considered, and the facility with which it may be disposed of. The landed proprietor should first make liberal provision for his domestic animals, and his household, and the labourers on his estate, before he thinks of raising any surplus products to be sent abroad. He will therefore so arrange his system of husbandry that his lands shall at all times present such a variety of crops, as will ensure subsistence to all employed in or immediately dependant upon their cultivation. The intelligent agriculturist will likewise endeavour as much as possible to diminish the labour and expense of transport, in the culture and management of such of his lands as are remote from his dwelling; and with this object, he will cultivate in preference on lands so situated, either crops of fodder and roots that may be consumed by his animals upon the spot, or such herbaceous or other plants as may be converted into manure, by being turned into the soil. He should be careful also, in the treatment of such of his lands as are of a light and open character, and at the same time so situated as to have a considerable descent, to cultivate on them such plants only as will cover the surface with their numerous leaves, and the roots of which will bind together every part of the soil, so that it shall be protected as well from being washed away by the rains, as from being dried up by the intense heat of the sun." In districts, too, which are advantageously situated for obtaining abundance of cheap manure, such as the neighbourhoods of many sea-ports and large towns, more frequent crops of the cereal grasses and of other very exhausting plants may be profitably raised than in districts where extraneous manure is either scarce or dear; and in the latter districts, on the other hand, crops of inferior market value may often be more profitably raised with such manure as can be obtained within the limits of the farm than crops of superior market value with manure either purchased from without or withheld from other fields. The frequency of any prime crop in a rotation, likewise, ought to be mainly controlled by the same considerations which determine the aggregate character of the rotation itself; for wheat, for example, may be profitably raised on every alternate year on some rarely rich soils, or every third year on very rich compact loams, and yet not oftener than in every fourth or every fifth year on moderately good loams, and never at all on inferior loams in the best districts or on good loams in remote situations. The profitable or most suitable duration of lea, also, in every system of rotation which alternates a period of grass with a course of aration, must be determined by a variety of considerations, such as the goodness and prolonged luxuriance of the pasture, the market price of live stock, the proportional profit of grazing as compared to that of tillage, and the comparative cheapness and abundance of lime, marl, police-manure, and other extraneous fertilizers. See the articles GRASS-LANDS and FALLOW.

The oldest rotation known is called the three-field system, and was practised all over Europe centuries before the principle of rotations was recognised, and seems even to have been in use among the ancient Romans; and consisted of fallow, autumn-sown wheat or rye, and spring-sown oats or barley,—every farm or tract of arable land subjected to it, even when held in commonage by many proprietors or many tenants, being divided into three parts, one of which was in fallow, one in winter corn, and one in spring corn. Some of the earliest improvements on the three-field system consisted in the introduction of green crops, particularly clover and turnips, in the room of the fallow; and one of the

most valuable and improved of these interposed clover between the spring corn and the winter corn, and raised turnips, after a plentiful manuring, in the early months of the fallow year, and in consequence produced the four-course system or Norfolk husbandry; and this is the most remarkable of all rotations in its effects on the history of English agriculture, and continues to the present day to command as high an attention as in the first ten or twenty years after it became known, and may be regarded as, in some sense, the type of the great majority of good modern English rotations, and especially as the model of the constant alternation of a white crop and a green one which pervades all a modern English farmer's notions of the proper treatment of corn-land. Another early and valuable improvement on the old three-field system consisted in laying down the land to grass in the year of the fallow, and allowing it to lie several years in lea; and this, together with various interpolations between the spring-corn and the winter-corn, amounting in some cases to an alternation of pasture with something like an English rotation, may be viewed as the basis of the best modern rotational usages of Scotland and of the most enlightened districts of Germany.

Three rotations common at the present day in Germany are mere extensions of the three-field system, and essentially retain its errors; and one of these extends through six years, and consists of 1. fallow, 2. winter corn, 3. spring corn, 4. pease and clover, 5. winter corn, and 6. spring corn,—another extends through nine years, and consists of 1. fallow, 2. winter corn, 3. spring corn, 4. clover, 5. winter corn, 6. spring corn, 7. pease, 8. winter corn, and 9. spring corn,—and another extends through twelve years, and consists of 1. fallow, 2. winter corn, 3. spring corn, 4. clover, 5. winter corn, 6. spring corn, 7. fallow, 8. winter corn, 9. spring corn, 10. pease, 11. winter corn, and 12. spring corn. One of the German systems of alternate pasture and tillage, is practised on the moderately good soils of Holstein, and consists of 1. three or more years of pasture, 2. oats on the newly broken-up grass, 3. cleaning fallow, 4. wheat, 5. beans or barley or oats, and 6. wheat, —manure being given always with either the last or the next last crop, and sometimes also with the first wheat; another, much practised in Mecklenburg, consists of 1. two years of lea, 2. well-manured potatoes or beans, 3. oats or wheat, 4. oats or barley, 5. manured pease or tares, and 6. wheat with white clover and grass seeds; another, found to be very suitable on well-managed moderately good soils, consists of 1. two years of pasture, 2. oats, 3. well-manured beans, 4. wheat, 5. manured tares, 6. barley, and 7. mown clover and grass; and another, adapted to very rich soils in the same way as the preceding to moderately good ones, consists of 1. two or three years of pasture, 2. well-manured rape, 3. wheat, 4. manured and hoed beans or potatoes, 5. barley, 6. clover, 7. wheat, and 8. oats with clover and grass seeds.

The Norfolk rotation, or four-course system of turnips, barley, clover, and wheat, though still the most characteristic of all the English rotations, has for many years been proving itself too limited in power, and is now regarded by all scientific farmers and by multitudes of mere practical ones as quite incompetent to bring fairly or tolerably out the resources of even the most favourable districts. "Though this system," remarked Mr. Pusey in 1840, "has conferred such great though silent benefits on the country, it may be doubted whether it have not accomplished all that it is capable of, and must not pass into another. Already it has begun to fail in one of its green crops, probably in the other. The red clover, it is admitted, can be no longer repeated once in four years, and the substitution of white clover, or of rye-grass, in the alternate fourth year, or the prolongation of the course to five years, by sowing rye-grass with the clover and thus leaving the ground in grass for two years successively, are but imperfect remedies. The evil, however, is likely to increase; for in Flanders, whence the red clover was originally brought over, and where the land has been long tired with its repetition, it has been destroyed in whole districts by a grey parasitical plant called orobanche, and the only cure has been the entire suspension of its cultivation in those districts for many years. It is well known also, that in Norfolk, where the turnip has been longest cultivated, that root has become subject to a disease which distorts it with unhealthy excrescences; and it may be worth inquiry whether, apart from dry seasons and the depredations of insects, the late general failure of the turnip be not in some degree owing to its too frequent repetition. Such being the ill results of a too scanty rotation, which consists in the endless repetition of four crops, the remedy must of course be sought in a greater diversity." See the articles Clover, Turnip, and Broom-Rape. The Norfolk system, too, besides being unsuited to soils which are too heavy for turnips or too poor for wheat, is ill adapted to thin clays or merely moderate loams in all comparatively cold and late districts, which are wholly or chiefly dependent for manure on their own resources; and is even regarded by some eminent agriculturists as uneconomical on the very best soils of such districts, except in a few choice places and under the most favourable circumstances. "Whatever the climate of England may be able to do in support of this system," remarks the Editor of the Q. Journal of Agriculture, it is one which that of Scotland cannot support on any farm, however good, situated at a distance from a large town,—the source of unlimited supplies of extraneous manures. Where manure to the extent of from 16 to 32 tons per imperial acre may be applied (and that is the rate of

dunging in the neighbourhood of Edinburgh and other large towns), it is quite possible to pursue it; but no farm of Scotland could practise it on its own resources. The straw off two acres will not sufficiently manure one; and that being the case, without extraneous assistance, the fallow division of a four-course shift cannot be manured as it ought to be." Yet, on the one hand, mere farm-yard manuring is not so very greatly controlled in its action by climate as this statement would seem to imply,—and may, in all unfavourable districts, be powerfully aided or supplemented by the use of special manures; and, on the other hand, difference of climate tells, not only against the pure Norfolk husbandry, but against all constant alternations of green crop and white crop, no matter how diversified the former may be, and even though rigid care be exercised to carry all the diversity of white turnip, Swedish turnip, potatoes, tares, clover, pulse and other green crops regularly over each field on the farm.

The approved rotations in use on strong good clay soils are very numerous and diversified. A simple and unintermitted alternation of wheat and beans is practised in some parts of Kent and Essex, and in a few places in Germany; and when maintained on soil thoroughly adapted to it, and with ample supplies of suitable manure, and with assiduous plying of the horse-hoe and the hand-hoe, and during no longer a period than while the land keeps properly clean and yields a full produce, it is generally the most profitable course of cropping which can possibly be followed. An excellent rotation, based on the alternation of wheat and beans, and adapted to the same kinds of soil, but much more extensively practicable, and comprising important cleaning and ameliorating interpolations, consists of 1. bare or turnip fallow, 2. wheat, 3. clover and ryegrass, 4. oats, 5. drilled beans, and 6. wheat,—and apportions one good dose of manure to the fallow-year and another preparatorily to the beans; and this rotation or a slight modification of it, with disposal of the clover and ryegrass of the third year in either hay, soiling, or pasture, as may be found most expedient, is a very favourite rotation on the heavy soils of the Lothians. Another rotation suitable for the same soils, but still more extensive, and possessing the recommendation of being manageable with a smaller number of horses than the preceding, and therefore at less expense, consists of 1. bare or turnip fallow, 2. wheat, 3. drilled beans, 4. barley, 5. clover and ryegrass, 6. oats, 7. drilled beans, and 8. wheat; and apportions one good dose of manure to the fallow year, a second to the clover stubble of the fifth year, and a third to the drilled beans of the seventh year. "On clay lands of the best quality, and in situations where manure is plentiful," says Mr. Donaldson, "a favourite rotation has been,—1. fallow, 2. wheat, 3. clover, 4. oats, 5. beans drilled and hoed, and 6. wheat. The manure may be applied on the oat stubble, or in the spring with the beans, if the nature of the land will admit. In the most favoured situations, this rotation is well adapted for alternation, and for keeping the land clean and in proper tilth. The four years' course of 1. fallow, 2. wheat, 3. clover, pease, or beans and tares, and 4. oats, is much esteemed by many eminent cultivators, and may suit on lands of good quality; but the recurrence of the same crop is too frequent on land of any quality, and it is gradually giving way to a more extended rotation. Where the land is loamy and sufficiently mellow to admit the growth of barley, rotations of six and eight years have been followed, and include a greater change of plants from that circumstance,—1. fallow, 2. wheat, 3. beans or pease, 4. barley, 5. clover, 6. wheat or oats; or, 1. fallow, 2. wheat, 3. pease, 4. barley, 5. hay, and 6. oats. Here the clover crop is too far removed from the fallowing process, which supposes the land in the best state of preparation for the reception of these small and tender seeds. A shorter course is sometimes used,—1. fallow, 2. barley, 3. clover, 4. beans or pease and tares, and 5. wheat; and also, 1. fallow, 2. barley, 3. pease, beans, and tares, and 4. wheat; or, 1. fallow, 2. wheat, 3. pease, and 4. oats. These courses may be varied alternately with clovers in the third year. The longer courses most approved are,—1. fallow, 2. barley, 3. beans, 4. wheat, 5. tares, 6. barley, dunged on stubble, 7. clover, 8. beans, and 9. wheat; and 1. fallow, 2. wheat, 3. beans, 4. barley, 5. clover, dunged, 6. oats, 7. beans, and 8. wheat. This course may be reduced to six years, by not dunging the clover ley and making oats the last crop. And also,—1. fallow, 2. barley, 3. clover, 4. beans, dunged, 5. wheat, 6. tares, and 7. wheat. The two wheat crops are too near each other, and the fifth crop might take the place of the second. Another course has been used,—1. fallow, 2. wheat, 3. beans, 4. barley, 5. clover, dunged, 6. oats, 7. beans, drilled, and 8. wheat. If the land be clean and in tilth for clovers, this rotation claims much merit, and may be improved by exchanging the fourth and the second crops for each other. The following course possesses much merit, and joins bean and pasturage farming,—a circumstance seldom met with, and which would rarely be allowed,—1. fallow, dunged, 2. wheat, 3. grass, 4. grass, 5. oats, 6. beans, drilled and hoed, and 7. barley. In many places the land is much too hard and stiff for barley, and then the course of four and five years with beans and oats may be adopted. On the inferior soils of this description, the following course may be usefully employed,—1. fallow, 2. wheat, 3. and 4. clovers, trefoils, seeds, or cinquefoil, and 5. wheat or oats, beans, pease, and tares. The seed crops may be prolonged if thought fit, and form a course of six years. Another rotation for inferior clays has been commended,—1. fallow, 2. oats, 3. 4. and 5. grass, 6. beans, drilled, and 7. wheat; and also, 1. fallow,

2. barley, wheat, or oats, 3. and 4. clovers, and 5. oats. A crop of winter tares sometimes precedes the fallowing process after being eaten on the ground, but the mode is generally imperfect, as a very effectual part of the process is usually performed by the time the first furrow is given to the land, and the state of cultivation is much inferior to the fallows that are effected from winter ploughings which have derived the benefits of the vicissitudes of atmospheric action. The custom is very frequent on turnip soils, and even in those lands the fallowing tilth is inferior, except in some few particular cases." A new rotation for heavy clay soils is recommended by Mr. J. S. Nowlson of Hertfordshire, as one which he has found, after an experience of some years, to answer well. One-fourth of the whole arable area, on this system, is disposed in wheat; and after the wheat comes an oat crop, the one-half of which is sown alternately with clover,—after that, sown with winter tares, to be eaten off green by fattening sheep,—and then, bastard fallow for wheat; and the other half is fallowed for turnips, partly to be eaten on the land and partly drawn off,—then, fallowed for spring tares or cole to be eaten off by sheep, and then ready for wheat again; so that a farm of 200 acres will show as follows,—50 acres of wheat, 50 of oats, 25 of winter tares, 25 of fallow for turnips, 25 of clover, and 25 of cole or tares.

Rotations suitable for loams and loamy clays are more diversified than those suitable for stiff clays, and especially comprise a greater number of valuable fallowing crops, and admit an ample scope and more effectual play of cleaning culture without the aid of naked fallows. An excellent one, practised on the dry fertile loams of East Lothian, in the district around Dunbar, consists of 1. turnips, manured, and generally eaten off by sheep, 2. wheat, with clover and rye-grass seeds, 3. grass, fed off by sheep or cattle, 4. oats, 5. beans, manured and drilled, and 6. wheat; and this admits of being extended to eight years by substituting barley for the wheat of the sixth year and by adding clover and rye-grass for the seventh year and oats for the eighth; and it also, in cases of peculiar subsoil or of special wants on the farm or of controlling circumstances in the district or the market, readily allows the turnips of the first year to be substituted by bare fallow, or by any one of several drilled green crops, or the oats of the fourth by pulse, or the beans of the fifth by winter forage plants. "A course of six years," says Donaldson, "is most approved on these soils,—1. green crops, 2. wheat, 3. clovers, cut for hay or soiling, or consumed by stock on the ground, 4. oats or leguminous plants, 5. winter tares or late turnips eaten on the land, and 6. wheat; or the four years' course,—1. green crops, 2. wheat, 3. clover, and 4. oats. Beans, horse and hand hoed, may be used after the oats, along with the winter tares in portions, and alternately as the rotation goes on, and the land will thus obtain a change of plants, and the green crops may be varied to suit a similar mode of cultivation. The four years' course,—1. turnips, 2. barley, 3. clover, and 4. wheat, is too short, and the same plants recur too frequently; and it has been proposed to double the course, and extend it to eight years, thus,—5. cabbages or mangel wurzel, 6. oats, 7. tares or pease, 8. barley,—and for two years more, 9. beans, and 10. wheat; and also,—1. turnips or cabbages, 2. barley, 3. clover and tares, 4. wheat, 5. potatoes and beet, 6. barley, 7. clover, and 8. oats or wheat; and also,—1. beet and potatoes, 2. oats, 3. clover, 4. wheat, 5. turnips and cabbages, 6. barley, 7. beans, pease, and tares, and 8. wheat. The rotation of eight or more years is a repetition of that of four years, with the object of changing the plants raised as green crops, and substituting a leguminous and clover crop alternately, so that each occurs only once in the course of the rotation. But this object may be attained by varying the four years' course in the fields as they occur for cropping in succession; and if the soil be not all alike suitable for similar cropping, a change in the plants will be necessary. A course of five or six years is usually preferred, and is generally found more commodious, as it affords full opportunity of cultivating the most valuable plants, and also of profitable alternation. A course of six years has been very usefully employed,—1. turnips and other esculents, 2. wheat, 3. beans, pease, tares, 4. barley, 5. clover, and 6. oats. Unless the land be very clean and in high condition, the clover crop is too far removed from the cleaning and manuring process, otherwise the different crops are well arranged. It would be desirable that one crop be eaten on the ground as an auxiliary manure to support constant cropping, as a leguminous crop is proposed in a similar course on clay fallows; and the course may stand thus,—1. green crops, 2. barley or wheat, 3. clover, 4. oats, 5. vetches, consumed on the ground, and 6. wheat; and in five years thus,—1. turnips, 2. barley, 3. seeds, 4. pease or tares, eaten on the ground, and 5. wheat or oats. These rotations apply to clay loams of the first quality. On those of an inferior description, and on the best turnip lands, rotations somewhat different are used, including grass for two years, where there are no grass lands for producing hay and pasturage for the stock. A course of six years includes the following crops,—1. turnips and other green plants, 2. barley or wheat, 3. and 4. clover, 5. beans, pease, tares, and 6. wheat or oats, alternately on the fields. A course of five years is followed by omitting the pease and beans, and sowing oats as the fifth crop; or pease and beans may be sown in the fourth year, and followed by oats. A course of eight years has been recommended,—1. turnips, 2. wheat or barley, 3. clover, 4. and 5. pasture, 6. oats, 7. tares, and 8. wheat; or it may be limited to seven years by

omitting one year of the pasture. These courses of cropping are adapted to loamy lands, and it may be safely affirmed that no better are yet known."

An interesting table of rotations for a farm of 100 acres was proposed by Mr. Blaikie to the French government many years ago, and was published in the Gardener's Magazine of 1830, and in the first volume of the Journal of the Royal Agricultural Society of England; and though tarnished with several objectionable points, it exhibits such a great number of crops, in such suitable succession, and all adapted to dry rich loam, that it cannot fail to suggest to reflecting farmers some valuable improvements. Two of the main objections to it are that lucern requires a peculiar soil and a southern climate, and that four cereal crops in seven years, especially when three of these are wheat, can nowhere be profitably attempted in Britain except on the very finest land; and one of the special recommendations is that, notwithstanding the great number and remarkable variety of its crops, each successive one, in general, is remedial and serves as an antidote to the exhausting or befouling action of its predecessor. The table is as follows:—

First Year. Acres.	Second Year. Acres.	Third Year. Acres.	Fourth Year. Acres.	Fifth Year. Acres.	Sixth Year. Acres.	Seventh Year. Acres.
30 Wheat	5 Turnips, 5 Cabbage, 2½ Field beet, 2½ Carrots, 10 Potatoes, 3 Vetches, 2 Beans	10 Oats, 5 Barley, 15 Wheat	15 Clover, 5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots	15 Wheat, 10 Oats, 5 Barley	10 Potatoes, 3 Vetches, 2 Beans, 15 Clover	30 Wheat
15 Clover	15 Wheat	10 Potatoes, 3 Vetches, 2 Beans, 15 Clover	30 Wheat	5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots, 10 Potatoes, 3 Vetches, 2 Beans	10 Oats, 5 Barley, 15 Wheat	15 Clover, 5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots
5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots	10 Oats, 5 Barley					
10 Oats, 5 Barley	15 Clover	15 Wheat	10 Potatoes, 3 Vetches, 2 Beans	15 Wheat	5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots	10 Oats, 5 Barley
10 Potatoes, 3 Vetches, 2 Beans	15 Wheat	5 Turnips, 5 Cabbages, 2½ Field beet, 2½ Carrots	10 Oats, 5 Barley	15 Clover	15 Wheat	10 Potatoes, 3 Vetches, 2 Beans

10 Lucern, which lasts seven years, and is then ploughed down, and succeeded by wheat.

Rotations on the poor kinds of clay soils which will not admit of the processes requisite for green fallow crops, must necessarily owe all their restorative influences to bare fallow and to grass, and are therefore much more limited and far less diversified than rotations for either good clays or any of the loams. A good one on the best kinds of such soils consists of 1. fallow, 2. wheat, 3. grass seeds, to be either mown or pastured, 4. pasture, 5. pease, beans, or tares, and 6. oats; one, on a somewhat poorer class of the soils, consists of 1. fallow, 2. wheat or oats, 3. grass seeds, to be either mown or pastured, 4. pease, beans, or tares, and 5. oats; another, on a similar class of soils as the preceding, consists of 1. fallow, 2. wheat or oats, 3. grass seeds, 4. pasture, and 5. oats, pease, beans, or tares; and one on high-lying lands which are unsuitable for pulse or tares, consists of 1. fallow, 2. oats or barley, 3. grass seeds, 4. and 5. pasture, and 6. oats. A good rotation on the better sort of poor clay soils which have just been pared and burned, consists of 1. cole, rape, or turnip, 2. wheat or oats, 3. tares or grass seeds, 4. pease or beans, 5. oats, 6. fallow, 7. wheat, with grass seeds, and 8. a number of years of pasture; and a good one for the inferior sort of poor clay soils which have just been pared and burned, consists of 1. cole or rape, 2. oats, 3. pease, beans, or tares, 4. oats or wheat, with grass seeds, and 5. a number of years of pasture,—or, in some instances, cole and oats may be repeated in respectively the fifth and the sixth years, and the pastures commence in the seventh.

Rotations on light, poor soils of sand, chalk, gravel, and inferior loam, must be greatly controlled by the specific character of the land, by the nature of the situation, and by the local demands of the farm; and, in many instances, cannot profitably comprise either the cereal grasses or the large root crops, and need to be restricted to herbaceous and leguminous forage crops and to pasture grasses for the feeding of sheep. A good one on very poor loams consists of 1. turnips, 2. barley, with clover and grass seeds, 3. mown clover, 4. pasture, and 5. oats,—or 5. pasture, and 6. oats, pease, or tares; one for dry sandy soils consists of 1. turnips manured and eaten off, 2. barley or oats, with grass seeds, 3. 4. and 5. pasture for sheep, and 6. rye or oats; one for the better sort of sands, gravels, or chalk, consists of 1. turnips, 2. barley, 3. winter tares, eaten off, 4. rape, eaten off, 5. spring vetches, eaten off, and 6. rye grown to seed; another for the same kind of soils as the preceding consists of 1. turnips, 2. spring vetches, 3. rye, grown to seed, 4. winter tares, 5. rape, and 6. barley; one for the inferior sort of sands, gravels, or chalk, consists of 1. tur-

nips, 2. barley or oats, with clover and grass seeds, 3. clover, 4. tares, and 5. cole; one for sandy, peaty, or chalky soils which have just been pared and burned consists of 1. turnips, cole, or rape, 2. barley or oats, with grass seeds, 3. 4. and 5. grass, 6. oats, 7. tares or pease, 8. turnips, 9. barley with grass seeds, and 10. a number of years of grass; and another for the same soils as the preceding consists of 1. turnips or rape, 2. barley, with grass or clover seeds, 3. and 4. grass, 5. pease, 6. rye, 7. turnips, 8. barley, with grass seeds, and 9. a number of years of grass.—*Davy's Agricultural Chemistry.—Liebig's Chemistry of Agriculture.—Chaptal's Chemistry of Agriculture.—Goodrich Smith's Economy of Farming.—Donaldson on Manures.—Boussingault's Rural Economy.—Arthur Young's Works.—Thaërs Principes Raisonnés d'Agriculture.—The Edinburgh New Philosophical Journal.—Communications to the Board of Agriculture.—Sir John Sinclair's General Report of Scotland.—Radcliff's Report on the Agriculture of Flanders.—Buel's Farmer's Instructor.—Low's Elements of Agriculture.—Rham's Dictionary of the Farm.—Journal of the R. Agricultural Society.—Q. Journal of Agriculture.—Tower's Gardener's Manual.—Lindley's First Principles of Horticulture.—Stephens' Book of the Farm.—Dickson's Husbandry.—Dr. Dickson's Practical Agriculture.*

ROT IN TIMBER. See Dry-Rot.

ROTTBOELLIA. A genus of curious, tropical grasses, of the ophiurus tribe. Two perennial species, the perforated and the exalted, respectively 3 and 8 feet high, have been introduced to British collections from India; but they require stove heat, and are mere curiosities.

ROUGH CHERVIL. See Anthriscus.

ROUGHINGS. Aftergrass. The word is provincial.

ROUP. The most common and most fatal of the diseases of poultry. It considerably resembles glanders in the horse; and has a contagious or infectious character; and particularly attacks ill-fed fowls, in close and filthy places. The symptoms of it are swelling around the eyes, discharge from the nostrils, and a limpid but eventually purulent and fetid drivelling from the mouth. All fowls attacked with it ought to be promptly and perfectly separated from the rest of the flock; and all yards or courts or other places where it breaks out ought to be thoroughly cleaned, and henceforth kept in a tidy, sweet, and well-ventilated condition. Medicine can do little for it; yet many nostrums are prescribed by country people, and more or less possess the reputation of efficiency; and probably among the best of these is a sufficient quantity of strong solution of common salt to act as an emetic, and a mass of garlic, rue, and butter, well beaten together and crammed down the throat. The grand remedies, however, are prevention, by cleanliness, ventilation, and proper feeding, for the sound,—and warmth and thorough shelter, combined with proper ventilation, for the sick. See the article Poultry. Roup attacks not only the common gallinaceous fowls, but all the feathered inmates of the yard, even ducks and geese; and in the case of the last of these, it takes the name of gargle.

ROWAN-TREE. See Ash (Mountain).

ROWEL. An artificial means of prolonged subcutaneous irritation in the chest, belly, thighs, or other members of the horse. It commonly consists of a circular piece of leather, having a hole in the centre, and either wrapped round with simple tow, or smeared in addition with turpentine or digestive ointment; and it is inserted into an incision of about an inch in length made through the skin with a pair of strong short-bladed scissors, and widened by manual separation, to the extent of about an inch all round, of the integument from its subjacent attachments. It acts on the same principle as a blister, but so prolongedly as to produce an artificial abscess; it is of great service in many kinds of deep-seated inflammation; and as soon as it establishes a discharge, a daily dressing should be given.

ROWEN. See Aftergrass.

ROWTY. Over-rank, or too luxuriant. But the word is provincial.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND, ROYAL AGRICULTURAL IMPROVEMENT SOCIETY, and ROYAL DUBLIN SOCIETY. See Agricultural Societies.

ROYENA. A genus of ornamental, white-flowered, evergreen, Cape-of-Good-Hope shrubs, of the ebony family. About a dozen species, varying in height from 4 to 8 feet, have been introduced to the greenhouses and conservatories of Britain. Most love a soil of peaty loam; and all are propagated from cuttings.

RUBBERS. The scab in sheep. See the article Scab.

RUBBING-POST. A timber post or stone pillar, set up in a field for cattle, hogs, and other domestic animals to rub themselves against. It both is useful in itself, and serves as a decoy-protection of trees, gates, and fences.

RUBBLE STONES. Loose stones or loose brick-bats, or any similar loose materials, piled on one another, for any purpose of drainage, embankment, or coarse masonry.

RUBIA. See Madder.

RUBUS. See Bramble.

RUDBECKIA. A genus of hardy, herbaceous, yellow-flowered, North-American plants, of the sunflower division of the composite order. A number of species which formerly belonged to it are now assigned to the genus *Centrocarpha* and *Echinacea*. Five or six perennial-rooted species, and one annual species, which occur in British collections, still belong to it; and they vary in height from 3 to 8 feet, and all thrive on any common soil, and for the most part bloom in autumn. Four of them, the clasping-leaved, the

digitate-leaved, the pinnate-leaved, and the cut-leaved, are readily distinguishable from one another by the form of their leaves; and the last of these has an average height of 6 or 7 feet, and blooms from July till September, and has been recommended as worthy of trial in the field as a forage plant.

RUDDLE. An ochreous or ferruginous, reddish, loose, pulverulent mineral substance, found in Derbyshire and in other parts of England, and much used, from a remote period, for marking sheep.

RUE,—botanically *Ruta*. A genus of thalamiflorous plants, principally evergreen undershrubs, constituting the type of the natural order Rutaceæ. This order is large and interesting; and occupies an intermediate station, both botanically and economically, between the wood-sorrel family and the quassia family; but it has not any uniform or very distinctive character, and might, without impropriety, be regarded as a collection of several small and successively allied groups. Some of its species are fetid herbs of the temperate parts of the northern hemisphere; some are handsome, aromatic, heath-like shrubs of the southern hemisphere, particularly of southern Africa; some are trees of the tropics, with a panicled inflorescence of pale and very small flowers; some are shrubs of Australia, with long or broad leaves and with a stellate pubescence; and some have characters or stations somewhat different from all these. Some of the genera, such as *Ailantus* and *Corræa*, contain highly ornamental plants; and still more, such as *Cusparia*, *Brucea*, *Ruta*, *Peganum*, and *Zanthoxylum*, contain medicinal species. Nine or ten hardy species, about 150 greenhouse species, and about 20 hothouse species, occur at present in Britain, and are distributed among nearly 40 genera. See the article Diosma.

The rue genus comprises about 20 species, chiefly natives of countries around the Mediterranean; but it concentrates all its main interest in the common or heavy-scented species, *Ruta graveolens*. This plant was introduced to Britain nearly 3 centuries ago from the South of Europe; and is cultivated in gardens for various small purposes of medicine and economy. It is a hardy evergreen shrub, of commonly about 3 feet in height. Its stems are branching and bushy; its lower parts are ligneous, and have a grey, rough, striated bark; its upper branches are smooth and pale green; its leaves are bipinnate, and have the pinnæ distantly set from one another; its leaflets are sessile, obovate, slightly crenate, thickish, and glaucous; and its flowers grow in terminal branched corymbs, and have a five-petalled pale greenish yellow corolla, and bloom from June till September. The leaves have a hot, bitter, nauseous taste, and a heavy disagreeable odour; they yield, by distillation, a volatile oil, which possesses all their virtues, and is the seat of all their medicinal value; and, when fresh, they are so acrimonious as to irritate and even blister the skin. The oil, the extract, and the powdered leaves are used in human medicine; and possess stimulant and anti-spasmodic properties; and are serviceable principally in hysteria, in flatulent colic, and in female complaints.—Rue loves a poor rubbishy soil, containing calcareous intermixtures; and may be grown on an unsheltered spot; and is usually propagated from slips and cuttings, planted in spring, but may be propagated also from seed. Plants of it in the garden should be kept moderate in size by cutting, and not allowed to go to seed.

RUE (Meadow). See Meadow Rue.

RUELLIA. A genus of ornamental, exotic plants, of the acanthaceous order. About 30 species have been introduced to the gardens of Britain, principally from the tropics; and upwards of 50 more are known. Two Indian ones, *R. ringens* and *R. strepens*, possess some native medicinal reputation. A few of the introduced species are evergreen undershrubs; the majority are evergreen shrubs; and most have a height of between 12 and 40 inches, and carry either blue or purple or red flowers in the end of summer or in the beginning of August. Most also love a soil of loam, and may be propagated from cuttings. The tuberous-rooted species, introduced about the middle of last century, may be selected as a sufficient specimen of the whole. "This," says Miller, "grows naturally in many of the islands of the West Indies. The roots of it are composed of many swelling fleshy tubers which run deep into the ground, and are like those of the day lily, but are smaller. The stalk rises about 4 or 5 inches high, and sends out 2 or 3 short side branches, garnished with leaves placed opposite. Some of these are small and shaped like a spatula, others are much larger; they have short footstalks, and are a little crenated on their edges. The flowers are produced on the side and at the end of the stalk; those on the side have 2 flowers upon each footstalk, which come out opposite at each joint; but those at the top sustain 3. The flowers have narrow tubes about an inch long, then they spread out to a sort of bell shape, and at the top are cut into 5 obtuse segments, which are large and spread open; they are of a fine blue, but of short duration, each flower seldom lasting in beauty one day. After the flower fades, the germen becomes a taper pod 1½ inch long, having two cells, which when ripe, burst with a touch, and cast out the seeds to a distance. It flowers in July; and the seeds ripen in the beginning of September."

RUFF,—scientifically *Machetes Pugnax*. A British bird of passage, of the longirostrous family of waders. It particularly frequents the fens of the east of England, and is common to the coast of France, and to the whole of the north of Europe. The male is celebrated for

furious pugnacity at the breeding season; and he has then a partial covering of red papillæ on his head, and a ruff or thick collar of feathers round his neck; and this ruff gives the popular name to the species, and is so variously coloured and arranged, and so fantastically diversified in the projecting position, as never to be quite alike in two individuals; and even the general plumage, at other seasons as well as the breeding one, exhibits so great diversity as to have led hasty naturalists into the describing of many imaginary species. The prevailing or most frequent colour of the head, ruff, and shoulders, is shining purplish black, barred with chestnut,—of the belly and the rump, white,—and of the rest of the plumage, chestnut, black, and brown; and the characters strictly permanent, or those at least by which the bird may always be identified, are yellowish feet, semi-palmated external toes, and a strictly sandpiper bill and carriage. The male has a total length of about 12½ inches; and the female has a total length of about 10½ inches, and is called a reeve.

RULINGIA. A genus of ornamental, Australian, evergreen, small, white-flowered shrubs, of the byttneria family. Four species, all about 2 or 3 feet high, and propagable from cuttings, have been introduced to British collections.

RUMBLING DRAIN. See Draining.

RUMEN, or Paunch. The first of the four stomachs of a ruminating animal. It is situated immediately under the termination of the gullet; and receives in a series of pellets, a large quantity of vegetable matters coarsely bruised by a first mastication; and serves by its heat, its mechanical action, and its somewhat scanty moisture, to prepare these matters for further change. It is externally divided into two saccular portions, and internally lined with a rough and papillously studded membrane; and it has a very extensile texture, and becomes by far the largest of the four stomachs, and is sometimes much stretched out by over-gorging, and in general assumes a capacity exactly suitable to the kind and the comparative bulkiness of the animal's food. See the article Rumination.

RUMINANTS, or Ruminantia. The family or order of animals who have four stomachs, and who ruminate or remasticate their food. It is the most distinctly defined of all the families of mammals; and is also the most useful to man. Its genera are the ox, the sheep, the goat, the antelope, the giraffe, the stag, the musk, the llama, and the camel; and the fourth of these comprises also the gazelle, the chamois, the oryx, and the gnou. All the ruminants have a callous pad instead of incisors in the upper jaw, and are cloven-footed, and have four stomachs and a very long intestinal canal, and have their mammæ between the thighs. The flesh of ruminants furnishes all the principal kinds of meat used by man; their milk, especially that of the cow, supplies all the produce of the dairy; their fat affords all the varieties of tallow; and their hides, their horns, and their other parts all possess great economical value. Some of the living animals, also, particularly camels, are very valuable beasts of burden.

RUMINATION. The remastication of food by a ruminant animal. Liquid or attenuated food passes at once into the third and fourth stomachs, and is not remasticated; but all other food, particularly such as consists of comparatively dry and solid vegetable matter, descends into the rumen, is there slowly macerated, passes by little and little into the second stomach, and is there separated by compression into a liquid and a solid portion,—the liquid to pass on to the third and the fourth stomachs, and the solid to be returned in pellets up the gullet for such remastication as shall reduce it to a pulp, and fit it to pass direct, by re-deglutition, into the third and the fourth stomachs. The remastication is effected while the animal lies at ease,—and constitutes what is popularly called 'chewing the cud,'—and takes place only upon matter which nothing short of an operose process can reduce to perfect pulpiness or liquidity; and the regorging which attends it differs widely from the belching or vomiting of a non-ruminant animal, and is as regularly conducted by a specially constituted organism as deglutition or absorption or secretion or any other ordinary act or function of the animal system.

In order to understand the process of rumination, we must advert to the manner in which the four stomachs communicate with the gullet, and with one another. The gullet is an extensile membranous tube, much more complicated in ruminating quadrupeds than in man, the muscles which surround it being strong, and consisting of two rows of fibres, crossing one another, and running spirally in opposite directions; and these muscles, by their contractions, so powerfully force the morsel of food begun to be swallowed onwards into the inlet of the stomachs, that the process of deglutition once commenced cannot be stopped, even by the will of the animal. The gullet enters just where the first, second, and third stomachs approach one another, and discharges itself almost equally into the first and the second. Connected with it is another organ which may be termed the cud-duct. This is sometimes a groove and sometimes a tube, according to its action; and runs from the termination of the gullet to the third stomach, with the first stomach on the left, and the second on the right, and discharges itself almost equally into the second and the third. It has thick prominent margins, which can be brought to meet so as to form a complete canal, and thus constitute a continuation of the gullet across the second stomach into the third. All these parts, the gullet, the cud-duct, the first, the second, and the third stomachs, not only communicate with one another, but all communicate by a common point, the point where the gullet

terminates, where the cud-duct commences, and towards which the three stomachs open or end. Now in the process of returning the macerated food for re-mastication, it is the cud-duct, together with the shut termination of the gullet approached to the shut inlet of the maniplies, which forms the pellets. To understand the mechanism by which these are moulded, let it be marked, first, that the cud-duct extends from the termination of the gullet to the inlet of the maniplies,—secondly, that when it contracts, it approaches one or other of these apertures,—thirdly, that of these two apertures, the termination of the gullet is habitually shut, and the inlet of the maniplies, naturally straight, can be so narrowed as almost to close by its own contraction,—and fourthly, that when the first two stomachs, compressed by the abdominal muscles and the midriff, contract, they push in consequence the materials which they contain both against the two apertures opposite to each other, and against the cud-duct opposite to the two stomachs. The two stomachs, in this manner, in proportion as they contract, push the materials contained in them between the margins of the cud-duct, and the cud-duct also contracting, causes the two apertures of the gullet and of the maniplies to approach, while the two apertures being closed and brought near together, seize upon a portion of the aliment, and detach it in the form of a pellet. The aperture of the gullet is closed during the act of detaching the pellet, because at that instant the midriff is contracted, and it only opens when the midriff is relaxed; and the aperture of the maniplies is closed, because at that instant the maniplies, as well as the other stomachs, is contracted. From these circumstances, it is obvious that the pellet must be detached, as it could not otherwise be seized by the two approaching apertures,—that the pellet must be round, for this is the form of the cavity formed by the parts of the organ employed in the process,—and that the pellet must be about an inch in diameter, for the cud-duct, when contracted in the act of forming the pellet, is about an inch in length. How beautiful a contrivance,—how exquisitely adapted to the structure and wants of the animal,—and how minutely and highly illustrative of the all-pervading beneficence and skill which everywhere shine out in the works of the Creator!

One important practical lesson suggested by the nature of rumination, is the proper feeding of cows, in order to produce the greatest quantity of milk. If they are fed on very dry food, such as hay, the greater portion of fluids in the blood will be spent in the process of rumination and digestion, and the milk will be scanty; but if they be fed on aliment which abounds in liquid, such as mangel wurzel or brewer's grains, and distiller's wash as in Holland, they will ruminate much less, a less quantity of saliva will be wanted for chewing the cud, and a large proportion will go to the production of milk, though this will be thinner, and not so rich in cream as the milk produced from drier food. It is questionable whether cows fed wholly on distiller's wash would ruminate at all any more than calves, which so long as they suck, never ruminate.

Another important practical lesson has reference to the giving of medicines, and is stated as follows by Clater:—"We may, to a very great extent, send medicine into what stomach we please. We may give it in a ball, and it will fall into the paunch, and thence go the round of all the stomachs: or it may be exhibited in a fluid form, and gently poured down, and the greater part of it passed at once into the third and fourth stomachs. That which is meant to have a speedy action on the constitution or the disease should be given in a fluid form. That also which is particularly disagreeable should be thus given, otherwise it will enter the paunch and be returned again in the process of rumination, and disgust the animal, and, perhaps, cause rumination to cease at once. This would always be a dangerous thing, for the food retained in the paunch would soon begin to ferment, and become a new source of irritation and disease."

A third important practical lesson has reference to the sweating of the domestic ruminants, particularly sheep. Sweat is a production of the fluid portion of the blood, or arises from the same source as the salivary secretion employed in rumination; and hence the flow of it is more to be dreaded in ruminating animals than in others, inasmuch as it greatly diminishes the supply of fluid which ought to be employed in rumination. If sheep are sweating while they ruminate, there will be two evacuations of fluid at the same time, the body will be dried, and the blood exhausted and heated by the loss, while thirst will supervene, so as to make them drink till they are incommoded and their temperament altered. Sweating is also hurtful to sheep in other respects; for the fibres of their wool are thereby deprived of a part of their nourishment, which the sweat carries out of their body, while the heat which occasions the sweat causes the wool to grow too rapidly to acquire sufficient consistence.

RUMEX. See Dock.

RUNDALE. A peculiar and most mischievous kind of land-tenure in some parts of Ireland. It distributes each natural division of a tract or townland among all the tenants or small proprietors of the whole tract; and is therefore the very worst possible kind of commonage, and may be regarded as the modern and aggravated form of the old English system of common-field, and the old Scotch system of runrig. See the articles Common and Runrig. An occupant by right of rundale may have his proportion of a tract in 30 or 40 different patches, all without fences, and some so very small as not to need more than half a stone of oats to sow them. All rundale occu-

pants regard themselves as entitled to a portion of each kind of soil or surface in a townland; and whoever has a very good piece at one extremity, may have a very bad piece at the opposite extremity, and a middle-rate piece in the centre, and two or ten or twenty pieces of intermediate quality between. This miserable system produces endless confusion, trespasses, disputes, litigation, and fighting, and effectually prevents all georgical improvement, and even incites all occupants to cultivate the land with the least possible amount of manuring and labour. On a certain day in autumn, all the cattle belonging to a townland are brought from the mountains, or outlying pastures, and sent indiscriminately over all the arable land, and kept there in perfect commonage till a certain day in spring; so that no man can grow clover or other green crops, or can allow a late crop of potatoes in a backward year to remain in the ground till they ripen, or can perform any winter-fallowing operations, or can practise any system of husbandry whatever except the rudest and most unproductive. Even if a piece of bog or mountain should be reclaimed by any man of more than ordinary industry or enterprise, it is liable to be taken from him as soon as he has got one crop off it, and divided among all the tenants of the townland.

RUNRIG. An old Scottish tenure of land, of the nature of commonage. A large portion of the arable land of Scotland was formerly under this tenure; and seems to have been originally laid out in alternate ridges belonging to different vassals, and afterwards became separate properties in perpetual feu-rights, similar to the English copyholds of inheritance. "The origin of these intermixed patches of property in arable land," says Sir John Sinclair, "has been endeavoured to be accounted for in different ways. Some have conceived that it was on purpose to establish a common interest in the defence of their lands or their productions among the occupants; but it was more probably occasioned by the poverty of our ancient peasantry, requiring two, four, or even more, to unite in furnishing the numerous oxen then requisite for working a plough." This destructive system began to be broken up under the authority of an act passed in the year 1695; and it long ago ceased to disgrace any of the improved districts of the kingdom; yet it still leaves traces, or even remains entire, in some of the remote parts of the Highlands and Islands.

RUNT. See Cattle.

RUPPIA. A small genus of floating plants, of the order Fluviales. The sea ruppia, or tassel pondweed, *R. maritima*, is a perennial indigen of the salt-water ditches of various parts of Britain. Its herbage is submersed; and its flowers have a herbaceous colour, and bloom in July.

RUPTURE, or Hernia. The protrusion of some part of the intestines from their proper cavity. In the horse, it is not frequent; and is caused by accidents, kicks, over-exertion, and violent straining; and may be distinguished from a swelling or tumour by disappearing beneath the pressure of the fingers; and reappearing as soon as the pressure is withdrawn; and in some cases is so trifling as not to cause the animal any inconvenience, but in general is sufficiently serious and peculiar as to require treatment by a veterinary surgeon. In the cow or the ox, it is sometimes very bad from goring or from some similar accident, and can be properly dealt with only by a person of much surgical skill, and certainly should never be tampered with in the way of trying to return the bowel by mere manipulation. Some calves are born with rupture; and all such should, with the utmost care and speed, be fattened for the butcher.

RUPTUREWORT,—botanically *Herniaria*. A genus of curious, green-flowered plants, of the paronychia family. Their name alludes to their supposed medicinal virtue. The smooth species, *H. glabra*, is a procumbent or trailing, perennial-rooted indigen of the sandy and gravelly soils of some parts of England. Its root is tapering and somewhat woody; its leaves are stalked and obovate; and its flowers are small, and grow in dense clusters, and bloom in July. The herbage of this plant has a saltish taste, and possesses astringent and diuretic properties; and the juice is alleged to have the power of clearing away specks from the eyes.—The hairy species, *H. hirsuta*, resembles the smooth in at once character, duration, height, and habitat; but is more rare, and has a rough stem and hairy leaves, and blooms in July and August.—Two annual species, and four or five perennial ones have been introduced from the South of Europe.

RUSCUS. See Broom (Butcher's).

RUSH,—botanically *Juncus*. A genus of endogenous, herbaceous, coarsely grassy-looking plants, constituting the type of the natural order Junceæ. This order is nearly allied, on the one hand, to the sedge family, and, on the other, to Fluviales or pondweeds and duckweeds; but it wants uniformity or close definedness of character, and comprises plants of somewhat widely dissimilar appearance. A few of its species carry pretty yellow flowers; but most are rigid, coarse, unpleasant-looking weeds. One genus has the habit of a low palm; and the others present more or less the appearance of carices, sedges, or stiff, smooth grasses. Some species, particularly some of the British ones, indicate by their presence a deep and rich, though moist and neglected soil; and other species, amounting to the great majority, occur only on lands which are waste or more or less barren. About 60 hardy species and about 20 tender and half-tender ones have a place at present in the British Hortus; and three-fourths or so of the whole belong to the two closely allied genera, juncus and luzula,—and the rest are distributed among five other genera.

A number of the true rushes, or species of the genus juncus, occur largely in the moist pasture lands of Britain; and are significant indicators of wetness of the soil, and generally wasteful occupants of ground which a proper course of draining and georgical improvement might render highly productive. They are cropped, in their young state, by cattle,—and are converted, in upland districts, into hay; but they constitute very inferior herbage in all sorts of pastures and meadows, and are downright, destructive, abominable weeds in every kind of alternately grass and arable land. The extermination of them always requires thorough subsoil draining,—and sometimes the application of saline or calcareous top-dressings, or of sand, road-scrapings, or some similar substances,—and, in the worst cases, a subsequent course of tillage; and it need never be attempted by merely breaking up the surface,—for though this may temporarily subdue them, it makes no true or vital impression on them, and will allow them to reappear in all their power and plenteousness as soon as the land is laid down again to grass.

The conglomerated rush, *J. conglomeratus*, is one of the most frequent in the low meadows and moist low pastures of all parts of Britain; and is often called the common rush. It has a height of about two feet, and blooms in June and July. This species and the next four which we shall name, are used for making rush-lights and for a number of well-known economical purposes; but have, for a good number of years past, been mainly substituted in the latter by one of the most common of the club-rushes. See the article Club-Rush.—The soft or effuse rush, *J. effusus*, abounds in the same sort of situations as the conglomerated rush; and has usually a height of about 3 feet, and blooms from May till August. This species is cultivated in some parts of Eastern Asia for making floor-mats.—The sea rush or lesser sharp sea rush, *J. maritimus*, occurs in salt marshes in various parts of Britain; and has usually a height of about 4 feet, and blooms in August.—The sharp rush or greater sharp sea rush, *J. acutus*, occurs on the sea coasts of various parts of Britain; and has usually a height of about 6 feet, and blooms in July and August.—The glaucous rush, *J. glaucus*, inhabits the same kind of situations as the conglomerated and the soft species, in some parts of England; and has a height of two feet, and blooms in July; but is comparatively scarce.—The sharp-flowered rush, or sharp-flowered jointed rush, or sprit, or sprat, *J. acutiflorus*, abounds in many sorts of moist ground in both the high and the low districts of Britain, and often forms the greater part of the herbage of bogs and peat-meadows; and though not readily eaten by any of the grazing animals, except in the absence of better food, yet, when made into hay, is somewhat freely eaten by the hardier breeds of cattle. It usually has a height of about two feet, and blooms in July and August.—The other indigenous species, together with their respective heights and habitats, are the Baltic rush, 20 inches high, on the sea coast,—the filiform rush, 6 inches high, in bogs,—the squarrose rush, 6 inches high, on sandy and gravelly heaths,—the shining-fruited rush, 2 feet high, in meadows and moist pastures,—the blunt-flowered rush, 20 inches high, in marshes and very wet meadows,—the three-flowered rush, 6 inches high, in upland bogs,—the two-flowered rush, 3 or 4 inches high, in upland bogs,—the bulbous rush, 12 inches high, in moist grounds,—the toad rush, an annual, the only indigenous species not perennial, 6 inches high, in wet shady ground,—the marsh rush, 12 inches high, in English turfy heaths,—the supine rush, 6 inches high, on Scottish mountains,—the chestnut rush, 12 inches high, in the Scottish Highlands,—the many-headed rush, 2 feet high, on Scottish mountains,—and the three-leaved rush and Gesner's rush, both but a few inches high, on some mountains of the Scottish Highlands.

Six species of the genus luzula are also indigenous,—the hairy rush, 6 inches high, and the tall or greatest rush, 2 feet high, in the woods of Britain,—the field rush, 6 inches high, in the barren pastures of Britain,—Forster's rush, 10 inches high, in the woods of England,—and the spiked rush and the arched rush, respectively 6 and 12 inches high, on the mountains of Scotland.

RUSH-NUT. See Cyperus.

RUSKY. A circular seed-basket, commonly made of rows of twisted straw, and provided with handles and a bottom-rim. It is used for carrying seed-corn to the sower, and is carried either on the head or in the arms.

RUST. Oxidized iron. It rapidly forms on the surface of any iron which is exposed to the joint action of humidity and the atmospheric air. It mainly consists at first of the protoxide of iron; but it afterwards passes gradually into the hydrated peroxide. It always contains ammonia. The means of preventing the formation must be such as either to secure perfect and constant dryness or to exclude the access or resist the action of humidity. The common method of a coat of paint acts in the latter way. See the article Iron.

RUST, Red-Rag, Red-Gum, and Red-Robin. Diseases of grasses and corn-plants, caused by minute fungi of the coniomycetous order. They are commonly ascribed by botanists to two species of the genus Uredo,—*U. rubigo* and *U. linearis;* but they probably arise from mere varieties, or from various ages and conditions, of the mildew fungus. See the article Mildew. They attack wheat at all stages of its growth; and are found sometimes on the young blade, occasionally on the stem, and very generally in the glumes and the paleæ, even after the grain is formed. The fungi have commonly a ferruginous, a yellow, a brown, or an orange colour; and those which have spherical spores are usually

said to be the *U. rubigo*, and those which have oblong ones the *U. linearis*. They form oval spots and blotches; and when the spores have burst through the epidermis, they are readily dispersed. The rust, the red-rag, and the red-robin varieties make the plants look as if they were dusted with a rustiness of some colour from yellow to brown; and the red-gum variety occurs only on the ear, and appears like gummy exudations, and consists in groups of red, minute, glutinous globules, interspersed with transparent fibres. Professor Henslow found the red-rag more common within the range of his observation than any of the other kinds; and he says, "It abounded in the form of an orange powder which exuded from the inner surfaces of the chaff-scales, but was scarcely, if ever, to be seen in the skin of the seed. It might also be traced in patches beneath the epidermis of the straw; but I did not observe that it had burst through the epidermis anywhere, excepting on the inside of the chaff. It seemed to prevail more among the rough-chaffed wheats than others." The rust, in its several varieties, is not so injurious as the true mildew; and is perhaps the least destructive of all the parasite diseases which attack wheat in Britain; and is somewhat readily dissipated by an outburst and continued play of sunny weather; but is generally more injurious, when it appears, in the later stages of growth, on the glumes and the paleæ, than when it appears, in the earlier stages, on the blade and the culm. The methods of preventing it are the same as in the case of mildew.

RUT. A small, narrow, surface drain, made intentionally with a spade, or unintentionally with the wheel of a cart or carriage.

RUTTING SEASON. The season of the lower animals, in their respective species, being in heat for pairing or for copulation.

RUTA. See Rue.

RUTA BAGA. See Turnip.

RYE,—botanically *Secale*. A genus of cereal grasses of the wheat tribe. The two glumes or outer chalf of its spikelets are bristly or awl-shaped, while those of wheat are large and so far valved or hollowed as to include a considerable portion of the lower floret; and this is the principal botanical distinction between the two genera.

The History of Rye.—Great obscurity hangs over the early history of rye; and considerable difficulty continues to the present day to attend the determination of some of its species and varieties. Certain interesting ancient notices of cereal grasses are thought by some commentators to refer to rye, and by others not; some plants which the botanists of a former age regarded as species of rye, are now assigned to the genera Triticum and Agropyrum; and two or three varieties, or perhaps species, which continue to be called rye, either hold a doubtful place between rye and wheat, or are not sufficiently known to be spoken of with certainty. Yet a few old facts respecting rye are well authenticated, and at the same time possess considerable interest.

Rye has been variously supposed to be a native of Crete, of the Crimea, and of the Levant or of Egypt; but it possesses the constitution of a plant inured to the coldest regions, and grows most abundantly beyond the Yakutsk on the surface of a frozen subsoil, and seems, on the evidence both of its own nature and of some of the earliest records of it, to have been introduced to all other countries where it is found from some northerly part of Asiatic Tartary. The grain mentioned by Moses and Isaiah, which the authorised English translation of the Sacred Scriptures calls rye, and by Herodotus, which some old scholiasts regard as rye, appears to have been the species of wheat formerly called *Zea spelta*, and now called *Triticum spelta*, and popularly spelt. Rye does not seem to have been known to Aristotle or Dioscorides, and is not mentioned by Cato, Virgil, Columella, or Varro, and may therefore be inferred to have held no place among the ancient agricultural crops of Greece or Italy. Pliny, however, describes it as cultivated by the Taurini in the part of Cisalpine Gaul which now constitutes Piedmont, and says that they call it Asia,—a circumstance which possibly may point to their ancestors having brought it with them remotely from Asiatic Tartary, and immediately from the valley of the Danube.

"Rye appears to have been in Pliny's time, as now, cultivated not alone for its grain, but also as fodder for cattle; for after saying, that rye and farrago (which he afterwards explains to be a thick sowing of tailing wheat mixed with vetches) required no other cultivation than a harrowing, indicating thereby that rye is best suited, as the fact is, to a light sandy soil, since a strong soil cannot be cultivated by a mere harrowing,—and that in Africa, barley (which Pére Harduin expounds to mean winter barley) is used for the same purpose, being sown together with a degenerate vetch, which Pliny calls cracca,—he adds, that all the articles which he has enumerated are destined for cattle food. Pliny further says, that rye is the worst of grain, and only fit to repel famine; that it is productive, but is of a slender straw; that it is miserable for its blackness, but remarkable for its weight; that wheat is sometimes mixed with it to mitigate its bitterness,—but that even so, it is most unacceptable to the stomach; that it grows in dry soil, and makes a return of a hundred grains for one, and itself suffices for manure, thereby probably meaning, that as it is a good forager, it will grow without dung. When we recollect that the means were familiar to Pliny of comparing rye with the splendid wheats of Italy, we may not, perhaps, much wonder at his low appreciation of this homely though nutritive and useful grain. Its use at that time as a bread-stuff was

probably confined to the elevated and inclement regions, where the chilling blasts descending from the Alps rendered the culture of superior grain precarious and unprofitable."

Rye was known and cultivated in Britain at a very early period. Spelman's Glossary speaks of ancient rents reserved in rye, showing it to have been anciently in extensive cultivation; and Worlidge and Ray, who wrote in the 17th century, enumerate it among the plants then commonly cultivated in Britain,—and the former assigns it a rank as a bread-stuff next to wheat. A practice long prevailed, both in Britain and in other lands, of sowing rye and wheat together; and the name given to this mixture was meslin or maslin,—a Norman word signifying corn, and seeming therefore to indicate a considerably high antiquity in this practice, and a corresponding antiquity and prevalence of the ordinary cultivation of rye. But the reputation of this grain as a bread-stuff, in Britain, gradually diminished during the progress of modern agricultural improvement, and may now be regarded as extinct. Yet rye is still extensively cultivated as a bread-corn throughout Poland, Russia, Switzerland, much of Germany, and other parts of Continental Europe; it is cultivated, both as a bread-corn and for other purposes, in some of these European countries, in some parts of America, and in other parts of the world; and it has of late years begun to challenge high attention as a forage-plant, as well as to maintain an old character for some important though comparatively small economical uses, in various districts of Britain. Its present rank among field-plants, therefore, may be regarded as one of permanent and reviving interest.

The Different Kinds of Rye.—The corn rye, *Secale cereale*, is the principal species, and comprises a number of varieties. It is an annual, and has ordinarily a height of about 3 feet, and naturally blooms in June and July.

Winter rye, *S. c. hybernum*, is the kind most generally cultivated in Britain; and is supposed to have been originally introduced from Tauria, while the normal corn rye was introduced from the Crimea. It is particularly adapted for poor moorish soils in upland situations, and, in general, for all sorts of inferior arable soils which are incapable of producing wheat. It serves, more or less, all the several purposes for which rye of any kind is wanted; and in some parts of Scotland, particularly in Orkney and in Argyleshire, it is grown exclusively for the manufacture of straw-plait. It is sown in autumn, and stands over winter, in the same manner as winter wheat; and therefore has a kind of biennial character.

Spring rye, *S. c. vernum*, grows more uprightly from the commencement than the winter rye, does not tiller so well, and is about 12 days earlier. Its culm, also, is more slender and a good deal shorter; its ear is shorter; and its grain is rather smaller, but heavy and of excellent quality. Yet notwithstanding its several and wide differences, it maintains them only when treated strictly as a spring corn; for when frequently sown under similar circumstances to those of winter rye, it becomes identical with that variety in both habit and appearance. Spring rye seems to have been known in Britain at least 70 years ago, yet has never come into extensive cultivation in this country. It was regarded by M. Vilmorin, in the intensely dry summer of 1818, as the best of the cereal grasses then known in France for growing rapidly and affording the earliest and readiest supply of green food to starving cattle in a year when all verdure was burnt up,—and it probably is surpassed in this important adaptation by no agricultural plant known at the present hour, except perhaps the *Setaria germanica* or moha or German millet; and it has, for some little time past, been getting into greatly extended cultivation, as a bread-corn, in some parts of France, and is there sown in March. A subvariety of it, grown in Germany, and called the great spring rye, is taller, and has longer ears, and is a little later, than the kind usually cultivated in France.

The Roman rye seems to be intermediate in character between the winter rye and the spring rye. "We owe this interesting variety," says the intelligent author of Le Bon Jardinier for 1846, "to the Marquis Doncieu de Chaffardon, whose son brought it, some years ago, from the environs of Rome. It is distinguished from other varieties readily by the lightness of its colour, and eminently by the great size of its grain. In autumnal sowings of it in France, it has completely borne the winter, and has remained a comparatively fuller plant than other winter rye grown by its side; and in spring sowings, it has freely matured itself to seed, and for the most part in good season." But it cannot yet be said to have acquired a steady character even in France; and as to Britain, it is but newly introduced, and has not yet been duly tested with the climate.

The midsummer rye or St. John's day rye is the most valuable of all the known and tested varieties of rye to the British farmer. It was introduced to France from Tuscany by M. Vilmorin, and from France to Britain by Dr. J. S. Duncan and W. P. Taunton, Esq.; and, for some time past, it has been rapidly rising in favour and greatly extending in cultivation. It differs very much from both the winter rye and the spring rye; it is considerably later in running to ear and in ripening than the winter rye; and it produces longer straw, much longer ears, and more root foliage. In France and other parts of the Continent, it is often sown in the end of June, and eaten down with sheep in autumn and spring till the latter part of April, and then allowed to run to seed; and it has the reputation of yielding a larger produce in grain when thus

treated than if it were grown in the usual way. The great length of time which it occupies between brairding and running to seed peculiarly qualifies it for this kind of treatment; and a habit which it has of powerfully tillering or of throwing up many stalks eminently fits it for being grown for soiling at so advanced a period in the season as the third or fourth week of June. On suitable soil, and when sown between the 21st and the 30th of June, and pressed down on light land by rolling or sheep-treading, it soon throws out a great mass of foliage, and eventually rises to the height of 6 or 7 feet, and may yield so much as 11 London loads of straw per acre when left for seed. "The mode of operation by which the St. John's day rye becomes so productive," says Mr. Taunton, "is its tendency to throw out extremely numerous branches from the same root; or, as it is expressed by farmers, to tiller out greatly; from which quality it has obtained its name of *multicaule*, or many-stalked rye. These branches are not all produced at the same time, but successively; and the season for their production is limited to the period during which the plant is not excited to throw up its culms; for after the culms have begun to rise, there is little or no addition made to their number. It is important, therefore, to the increase of the bulk of the crop, that the period between the germination of the seed and the rising of the culms should be protracted as long as possible. The longer it is, the more numerous will be the branches from a single root. This, therefore, is the cause of the marked advantage attendant upon sowing at midsummer." If the young crop be mowed or fed down once or twice before winter, it will grow vigorously again,—and a strong temptation to this treatment is held out by the luxuriant mass of herbage which it presents by about the month of October; but in all ordinary cases, it will compensate far better if left alone till spring. "The root-leaves," says the writer we have just been quoting, "neither die away in the same degree as those of the barley, nor are materially injured by the frost; and so soon as the influence of the vernal sun returns to the earth, the young leaves, under the shelter of these old leaves, shoot up among them, and attain nearly the same height as their nurses, regardless of the north-easterly winds; and the mixture of the old and young leaves furnishes not only a more bulky, but a heartier and safer meal for a sheep than the tender young shoots alone would do, for the earliest shoots of almost every sort of herbage often have too aperient a quality; while, if there had been no old leaves remaining, but if these new leaves had to rise into the cold air from the naked ground, they would not at that time venture to put out a shoot. This crop realizes, in an eminent degree, the benefits contemplated by the late Arthur Young, in strongly recommending the farmer to preserve the old fog, or aftergrass, of pasture fields, untouched through the winter, for the food of ewes and lambs in spring. You not only have the foliage you had in November, at a time when its specific value is doubled or trebled, but you have its bulk doubled also. There may, indeed, be cases, when an early sowing, combined with very rich or highly manured ground, or a soil fully stocked with charlock, may produce such a mass of autumnal foliage that it would in a long winter rot on the ground. In such a case it might be necessary to mow or feed it before winter; but that is an extreme case."

Cooper's early broad-leaved rye was brought into use about 3 or 4 years ago by Mr. Thomas Cooper of Ardleigh Wick, near Colchester, in Essex; and is an extremely valuable variety, of similar properties to the St. John's day rye, but considerably earlier. When sown in the beginning of September, it exhibits a surpassingly dense herbage and rich verdure in January and February, and becomes fit for soiling about the middle of April, and attains as great a height in the beginning of May as St. John's day rye sown at midsummer, but is liable to prove wofully deficient in grain at the time of harvest. Mr. Baker of Writtle in Essex, speaking apparently of this rye, says, "I know of no other food for early spring use, as a substitute for hay, equal to this." And Mr. Taunton says, "I strongly recommend to every farmer in the southern counties, who studies the increase of manure, and frugality in his stable and stall expenditure, to sow every year a certain breadth of Cooper's early rye, sufficient to last him from the middle of April to the second week in May or middle of that month; and a somewhat larger breadth of the St. John's day rye, to succeed the former, being sufficient to last him to the third or fourth week in June. With the aid of these two, he can well keep his stock tied up until the racer vetches, winter barley, common winter vetches, and clovers come in, and place him at his ease, with a latitude of choice of green fodder."

The many-stalked Russian rye, though sharing the name many-stalked with the St. John's day rye, bears a nearer resemblance to the common rye of the French than to that variety. Its leaf is broader and straighter and of a more tender green colour than the St. John's day rye; its time of coming to maturity is somewhat less late; and its grain is larger, more abundant, and of better quality. It does not tiller out more than the common French rye; it is longer eatable as green food for cattle than the English rye; and, though by no means equal to the St. John's day rye for fodder, it must be regarded as a very large, beautiful, and productive variety.

The Tyrolese giant rye was introduced a few years ago from the Tyrol, and has a general resemblance to the St. John's day rye; but tillers much less, and is considerably earlier, and does not afford so good a supply of green food for cattle. It has tall straw, and large heavy grain.

—The great northern rye very nearly resembles the Tyrolese giant rye; and affords a lofty and stiff straw, and a large, handsome, and heavy grain; but, even when sown in summer, does not tiller out more than the common English rye.—The Vierlande rye is also a very fine variety, conspicuous for its large and beautiful grain.—"Should the grain of rye be the cultivator's object, either for sale or for rearing or fattening cattle, the Tyrolese giant rye, the great northern rye, or the Russian broad-leaved rye, are better adapted for that purpose than the common rye or St. John's day rye."

The brittle rye, *Secale fragile*, was introduced to Britain from Tauria in 1816, and is regarded as a separate species. A variety of it, called perennial rye, has smaller seeds than the St. John's rye; and when sown in the beginning of April by Mr. Lawson of Edinburgh, showed no appearance of running to ear so late as December. Mr. Taunton, at one time, had this plant in his experiment ground; and thought it worthy of attention from its precocious habit, and from its promising early feed; and did not find it either backward or penurious in ripening its seed.

The eastern rye, *Secale orientale*, was introduced from the Levant in 1807; and is also regarded as a separate species; but is viewed by the distinguished Russian botanist Bieberstein as, not a rye, but a wheat. It has a biennial duration, and a height of about 3 feet, and a similar flowering-time to the common rye.

The composite rye, *Secale cereale compositum*, is set down in botanical systems as a variety of the common rye; but, if true to its name, it would seem to have a clustered spike like the composite or Smyrna or Egyptian wheat.

The Astracan rye lies shrouded in very provoking uncertainty. "For 30 years past," says Mr. Taunton, "has the author been vehemently desirous to obtain the rye of Astracan, reported by some writers to be the most beautiful grain that grows in the world; but all his endeavours have been fruitless; nor has he even been successful in ascertaining whether it be a real rye, and, if so, whether it be a species, or only a fine variety of *Secale cereale;* or whether it be, as some have surmised, merely the Polish wheat, *Triticum Polonicum*, a very remarkable and beautiful grain, which the writer has heretofore raised and admired."

The Cultivation of Rye.—The soils most suitable for all or any of the kinds of rye are such as contain a large proportion of silicious matter. Light sandy soils, totally unsuitable for wheat, are peculiarly favourable for rye; soils containing a considerable intermixture of argillaceous earth are moderately favourable; and calcareous soils, such as those of the chalk downs, are by no means suitable.

The quantity of seed for a crop of grain need not be more than one bushel per acre, on good land and at midsummer sowing, for the St. John's day rye; but must range from 2½ to 3 bushels, in ordinary circumstances, at respectively autumnal and vernal sowings, for the winter and the spring ryes. The quantity, in the latter cases, for straw-plait, however, should be more than doubled; and even the quantity of St. John's day rye, and of the kindred varieties, when intended chiefly for green food, may be advantageously increased. Rolling after sowing, particularly on very light land, is indispensable. "The wire-worm," remarks Mr. Taunton, "feeds greedily on the St. John's day rye; and I have found it to destroy an entire crop when the ground has been left hollow. Indeed, I consider abundant compression of the new sown soil by Crosskill's clod-crusher, or, in its absence, by other heavy rollers, and by the treading of sheep, to be most efficacious, if not essential, to the success of this crop."

The growing of rye in mixture with wheat, in the manner of the ancient meslin, is still occasionally to be seen in Britain, particularly in the north of England; but this is a bad practice, both because the two grains may not always happen to ripen together, and because land which is rich enough to produce wheat should not be employed for a less valuable grain. "The common rye is also used by unskilful persons to sow amongst winter tares or vetches, in order to support them, that they may not, by trailing on the ground, exclude the light and air and become yellow and lose their lower foliage. But it is ill suited to this end, because it grows so much faster than the vetches, that when the vetches are cut in blossom, the rye is become hard and has ceased to be eatable, consequently is wasted. Moreover, it grows so much faster than the vetches that it overtops, and, if the proportion of rye be large, it, by reason thereof, shades and injures them. The proper grain to use for supporting winter vetches is wheat; and for this purpose the sturdiest varieties of wheat are the best. By a beautiful adaptation of the means to the end, wheat grows exactly as fast as the vetches do, and no faster, and has exactly the degree of stiffness requisite to support them; and when they are to be consumed, the whole mass is eatable together, the wheat being the most nutritious and valuable part thereof."

The general management of rye culture is, in all respects, the same as that of wheat; and any peculiarities which arise from speciality of object or of circumstances, have been incidentally mentioned in our account of the several varieties. A very peculiar disease to which rye is subject, requires to be well-known, on account of its terrible effects when the grain affected by it happens to be used as human food. See the article Ergot.

The Uses of Rye.—The grain of rye, as a bread-corn, is regarded as of the utmost importance in the domestic economy of very many districts of Continental Europe. Bread made from it con-

tains a less quantity of nutritious matter than that made from wheat, and is commonly accounted slower of digestion; yet it keeps longer, and is thought by the Continental peasantry to contribute better to the maintenance of muscular strength, and is preferred by labourers in harvest-work and in other sevère labour. Rye grain, next to wheat, is certainly the most nutritive substance for bread; and it constitutes the only bread-stuff of many a high and poor region where the soil and the climate are unsuited to the growth of wheat. It is also used extensively, throughout the Continent, in both the brewery and the distillery.

Various mixtures of rye grain and other substances are excellent food for the rearing and fattening of the domestic animals. Bruised or coarsely ground rye, in Belgium and Germany and other parts of the Continent, is mixed with bruised or coarsely ground barley, oats, beans, pease, or tares, and formed into a kind of coarse bread for feeding domestic animals, particularly horses; and a similar compound is employed for fattening oxen. A mixture of rye-meal and skim-milk, with a small proportion of ground gold of pleasure, has been used, with signal success in Britain, in the rearing of calves.

The value of rye herbage as early spring-food for ewes and lambs and milch-cows, and to be cut green, after it has thrown up its culm, for soiling horses in the stable, has been incidentally noticed, with sufficient fulness, in our account of the varieties. The common winter rye, however, must be understood as but very imperfectly adapted to these uses; for it tillers badly, and affords comparatively small bulk of forage; and in a few days after it has put forth its culm, it becomes hard and sticky, and is rejected by the animals, and can no longer, without great waste, be employed in soiling. But the St. John's day rye, and Cooper's early rye, besides being naturally profuse in herbage, and constitutionally slow to pass out of their succulent condition, have the high advantage—though that, perhaps, is more or less shared by all the other varieties—of being peculiarly susceptible of excitement and luxuriant increase by irrigation.

The usefulness of the straw of the common winter rye for the manufacture of straw-plait has already been incidentally noticed. But the long straw of well-grown St. John's day rye has also its peculiar uses. When this straw is, as it may always be, of 6 or even 7 feet in length, it is well adapted for thatching, and for making reed-screens for garden use in places where marsh reeds are not easily to be had; and it possesses peculiar value for the purposes of collar-makers, since one length of it suffices to go entirely round the deepest collar, even for the largest stallion; and it has been currently sold for these latter purposes by Mr. Taunton, at what he calls "the comfortable price of £5 per ton."

One other useful quality of St. John's day rye, when cultivated for soiling, is the following:—"If it has been sown on deeply ploughed and friable ground, when the land comes to be ploughed up for turnips, it will be found that the stubble of each plant has attached to it a huge tuft of long fibres, retaining a considerable quantity of fine mould entangled between the fibres. After dragging and harrowing, if these be carted off, they will furnish an immense supply of dry absorbent matter for the bases and liquid ingredients of manure-heaps, or for bedding the yards. Indeed, it would be, in some instances, impracticable to drill turnips on land without removing them; so that unless the farmer resorts to the barbarism of burning so large a mass of useful vegetable matter, he is compelled to prepare for an economical management of his next dung-heap, whether he will or no."

The produce of rye per acre is estimated by Boussingault at 26 bushels, and by Burger and the author of British Husbandry at 25 bushels. The average proportion of grain to straw is stated by Boussingault to be as 45 to 100, and by Burger and Schwertz to be as 41½ to 100. According to Boussingault, one part of rye grain, when dried at 230° Fahrenheit, was reduced to 0·834, and, when incinerated, left 0·0237 of ash; one part of rye straw, when completely dried, was reduced to 0·813, and, when incinerated, left 0·0368 of ash; the grain consists of 46·35 per cent. of carbon, 5·38 of hydrogen, 44·21 of oxygen, 1·69 of nitrogen, and 2·37 of incombustible matter, and the straw consists of 49·88 per cent. of carbon, 5·58 of hydrogen, 40·56 of oxygen, 0·3 of nitrogen, and 3·68 of incombustible matter.—*Loudon's Hortus Britannicus.—Lawson's Agriculturalist's Manual.—Baxter's Agricultural Library.—Goodrich Smith's Economy of Farming.—Parmentier's Traité Sur La Culture Des Grains.—The Museum Rusticum.—Boussingault's Rural Economy.—Low's Elements of Agriculture.—Hunter's Georgical Essays.—Radcliff's Agriculture of Flanders.—Reports to the Board of Agriculture.—Miller's Gardener's Dictionary.—Von Thaer's Principes Raisonnés d'Agriculture.—The Quarterly Journal of Agriculture.—Papers by Messrs. Taunton, Pusey, and Baker in the Journal of the R. Agricultural Society.*

RYEGRASS. The agricultural species and varieties of the gramineous genus *Lolium*. A statement of their generic characters is given in the article Lolium; and ample notices of their economical value and uses, and of the methods of cultivating them for all ordinary purposes, are contained in the articles Grasses, Clover, Hay, After-grass, and Rotation of Crops; so that, in the present article, we need only to describe them, and to state how they may best be cultivated for the raising of seeds.

The common ryegrass, *Lolium perenne*, grows wild in the grass lands of Britain, and has been more extensively cultivated by British

farmers than any other kind of forage grass. Its root is fibrous; its culm is normally about 20 inches high; and its spikelets are beardless, and longer than the glumes. It is eminently fitted, by the fibrous structure of its roots, for the purposes of the alternate husbandry; it possesses adaptation to a great variety of soils; and it offers great facility of propagation by the profusion in which it produces seeds, and by the uniformity with which it ripens them;—and, in the strength of these properties, it has acquired, and possibly may long maintain, a far higher place in the estimation of British cultivators than it is fairly entitled to, either on the ground of its intrinsic worth as a nutritive grass, or in comparison with some other bulkier or more nutritious or better compensating herbage plants. It is exceedingly little known in North America; and though partially tried in Canada and the Northern States by emigrants from Britain, it has been found rather too tender to withstand the rigorous cold of their winters. It is scarcely known, also, in the South of Europe, or even in the South of France, and has been generally supposed unsuitable to any climate which has a hot and droughty summer; and it has not very long commanded the attention of farmers even in the north of France, but is now pretty generally cultivated there as a plant of acknowledged utility.

The varieties of the common ryegrass are numerous. A few produce a comparatively small quantity of root-leaves and a comparatively large number of culms, and usually flower and seed and perish in their second year, and are popularly termed annual ryegrasses; and the rest produce a comparatively large quantity of root-leaves and a comparatively small number of culms, and originally possessed, or have been generally believed to possess, a constitutional capacity of maintaining themselves through a series of years, and are popularly termed perennial ryegrasses. But the so-called annual sorts are seldom less than biennial, and may sometimes, by good management and on good soils, be rendered triennial; while some of the most permanent of the perennial varieties, or such as are most capable of reproducing themselves in their true or distinctive characters from seed, are reduced by unfavourable circumstances to a duration scarcely longer than that of some real annual plants; and others have been so changed in both characters and habits, by the influence of continual culture and of adverse soils, as to have lost almost all traces of the favourable properties by which they were originally distinguished. No means exist of distinguishing the annual or biennial kinds from the perennial ones by their seeds alone; and when farmers intend to have plants of more than biennial duration, and cannot rely on the characters of the crop whence they gather their seeds, they ought to refuse seeds from plants sown in the preceding year, and to save them only from vigorous, close, and freely-seeding plants of at least two years' standing.

The annual ryegrass is the only one of the biennial ryegrasses in ordinary cultivation. Its culms, besides being more numerous than those of the perennial varieties, are rather taller and have a smaller proportion of foliage. It has been commonly supposed, from the greater number and height of its culms, to yield a greater bulk of herbage in the first year than any of the perennial varieties, and therefore to be fitter for single crops of hay; but it makes a wirier and less palateable hay than these varieties, and is sadly deficient in bulk of root and of cauline foliage, and really possesses no peculiar good property whatever except the doubtful one of yielding a comparatively large produce of seeds. Most or all of its bad properties, too, as well as its merely biennial duration, are liable to be shared by plants raised from the seeds of the first year's crop of any reputedly perennial variety.

Whitworth's ryegrass, was introduced by G. Whitworth, Esq., of Acre House, in Lincolnshire, who, in 1823, had 60 varieties of ryegrass under experiment. It eminently possesses the properties of both early and late growth; and has so remarkably fine foliage as to adapt it well for mixtures of lawn grasses; and is so very vivacious, or takes so enduring a hold of the soil, that two or three ploughings are requisite to prevent it from springing out of a broken up lea, and injuring a succeeding crop.

Pacey's ryegrass occurs naturally in some rich meadow lands; and was introduced to notice by Mr. Pacey, a cultivator in the higher districts of Staffordshire; and was regarded by Sinclair as the most valuable of all the ryegrasses with which he was acquainted. Its root-leaves are numerous and large; its cauline leaves are long, yet have not so fine an appearance as those of Whitworth's ryegrass; and its spikelets are shorter, and contain fewer seeds, than those of most other varieties. This ryegrass is well adapted both for pleasure-grounds and for permanent pasture.

The compound ryegrass, or broad-spiked ryegrass, occurs naturally among long under-grass, on rich soils, principally in cart-tracts and other partially beaten parts. It has a short broad spike, crowded at the top with spikelets.—The Devonshire evergreen ryegrass, or Devon Evers, is remarkable for vigorously withstanding the severities of winter, and thence takes its name of evergreen; but does not yield so large a crop as some of the other varieties.

Russell's ryegrass was first cultivated by the late Mr. Holditch, Editor of the Farmer's Journal; and was named in honour of the Duke of Bedford, who pointed out, in a rich fen pasture, the plant whence the original seeds of it were obtained. It grows earlier in spring, remains later in autumn, has a much stronger habit of growth, and yields a greater bulk of pro-

duce, than either Whitworth's or Pacey's varieties.

The Church-bennet or Church-bent ryegrass is an excellent variety, cultivated in some parts of Berkshire.—Molle's ryegrass is a favourite variety in some districts; and though of a rather slender habit, grows tall, and yields a very bulky produce.—Stickney's ryegrass was introduced by Mr. Stickney of Holderness; and resembles Molle's in habit; but is stronger, more enduring, and both earlier and later.—Pollexfen's ryegrass was raised by Mr. Pollexfen of Kirkwall in Orkney; and resembles Stickney's; but has a darker green colour.

Seven pretty distinct varieties of ryegrass, which have received botanical designations, are described almost well enough by their mere names,—the more so as their peculiar characters possess far more interest for the mere botanist than for the farmer. These varieties are the slender, *L. p. tenue*, an inhabitant of dry impoverished pasture land; the humble, *L. p. humile*, only 6 or 7 inches high; the branchy, *L. p. ramosum;* the paniculate, *L. p. paniculatum;* the many-flowered, *L. p. multiflorum;* the monstrous, *L. p. monstrosum;* and the viviparous, *L. p. viviparum.*

The spreading ryegrass is remarkably stoloniferous, and differs very evidently from a stoloniferous variety mentioned by Sinclair, and is probably entitled to rank as a separate species, under the name of *Lolium stoloniferum.* Messrs. Lawson obtained seeds of it from Germany, and notice it as follows in their Agriculturalist's Manual:—"It was about a fortnight longer in running to seed in the nursery than any of the other varieties of ryegrass, and produced comparatively few flower-stalks. It is of early spring growth, pushing out long prostrate stolons or shoots, with an abundance of foliage, so that one plant, by the time the spikes begin to appear, will form a close tuft, extending from 2 to 3 feet in diameter. These shoots, however, although lying on the ground, never attempted to strike root until near the end of the season, and even then very sparingly. Entire height about 15 or 18 inches from the surface; but the length from the root to the point of the spike is often nearly 3 feet; spike long and slender; spikelets remote, small, and few seeded."

The thick-stalked ryegrass is noticed as follows in the same work:—"This variety was procured from Vilmorin & Co., Paris, under the name of *Lolium grossum.* It is nearly as remarkable for its stiff and upright habit of growth as the last is for its slender stoloniferous habit. Height about 20 inches; spike about 8 inches long, and very broad; spikelets, which are very long, placed so that the point of the one reaches to the base of the next above, containing each 8 or 10 seeds. The plants do not seem to grow freely in the beginning, but stand well out in the end of the season."

The Italian ryegrass, *Lolium italicum*, is regarded by some persons as a wide variety of the common ryegrass, and by others as a separate species. It is much more nearly allied to Stickney's ryegrass than to any other variety of the common ryegrass; but it is not so luxuriant, and it has always an awn or beard on its lower paleæ. One kind of it has an upright stem, a pale-coloured young herbage, and a comparatively long awn, almost like a tail; and another kind has a more fibrous root, a dark-coloured spreading stem, and a comparatively short awn. The Italian ryegrass has long been cultivated in Italy and in some other parts of Continental Europe; but it did not become known as a field-plant in Britain till within the last 15 or 18 years. It has a stronger braird than any of the varieties of the common ryegrass,—arrives sooner at maturity,—has taller and more upright culms, broader and lighter-green leaves, more abundant foliage, longer spikes, more thinly set spikelets, and a smaller size and less bulky produce of seeds. It is preferred by cattle to any of the common ryegrasses; and is greedily eaten by them, whether in its green or in its dry state. Its seeds are little more than half the weight, bulk for bulk, of those of any of the common ryegrasses raised under the same conditions of soil and culture. It is better fitted for being grown alone than in mixture with clover, lucern, or other herbage plants; for it grows so rapidly as to be liable to choke them. It has eminent adaptation to the production of only one year of grass; and though rushing speedily up to maturity, and though far more truly a biennial plant than a perennial one, yet when cut down before flowering, it is often of several years' duration. It may be sown in either spring or autumn; and if sown by itself in the latter, at the rate of from 16 to 18 lb. per acre, and properly rolled in, it will render the turf of the following autumn like that of an old meadow, and will yield more than a double crop in the following year. It has, indeed, been denounced by some farmers as a much less favourable preparation than the other ryegrasses for wheat or any other succeeding crop; but, if due attention be paid to the selection of its most suitable variety, it will be found almost or altogether as good a preparation as any of them of the same duration as itself, and at the same time will excel them both in productiveness and in intrinsic value. Public opinion has erroneously pronounced the light-coloured and long-awned variety to be the only true plant, and the dark-coloured and short-awned variety to be more or less spurious; and when this error comes to be generally corrected, Italian ryegrass will probably acquire a great increase of reputation. "Having observed," says Mr. Rodwell of Alderton Hall, "in the growth of my crop reported on in the Royal Agricultural Society's Journal in the year 1841, some plants that were, as I supposed, not genuine, that is, not of the pale colour, nor pro-

ducing with long awns, I determined upon a fresh importation of seed direct from Italy, from which I have since tested the properties of the two varieties, both of which I have since cultivated with great care and attention; and I am now fully convinced, from every comparison I have made, not only of the different kinds of plants in different fields, but of both kinds in the same fields, and in every case have satisfactory proof that the best grass, namely, that which is the most productive and the most nutritive for all cattle, is the plant which spreads upon the ground, is dark-coloured, and being the produce of seed with short awn; and my conclusion has been more fully confirmed during the past week by testing the varieties, both in weight and bulk, finding that the dark-coloured plants from the seed of the short-awned grass exceed both in weight and bulk the pale-coloured plants by more than 30 per cent. It will be also worthy the observation of those who intend to cultivate this grass, that if intended as a biennial or a perennial grass, in that case the dark-coloured is much preferable to the pale-coloured grass, the former branching and becoming thicker, and the latter spindling up and thus becoming thinner in plant every succeeding year."

When ryegrass seed is wanted, either a crop may be raised expressly for the purpose, or the thickest part of a hay crop may be reserved at the hay-season, and allowed to stand till it go into seed. In either case, the seeding grass must be cut down when the seeds are nearly ripe, and not allowed to stand till they are quite ripe; and shortly after it is mown, it must be carefully lifted, and tied into bundles a little smaller than corn sheaves. The bands used for tying should be made either of the grass itself, or of hay twisted into ropes. The sheaves are then stooked in the same manner as corn, for the purpose of drying; after which the ground is carefully raked, and the hay thus collected made into small cocks. When the sheaves have become sufficiently dry, they may be carried to the stack-yard, and built in a small stack, well ventilated by means of a funnel up the centre, which admits a free current of air, the seed being thrashed out in spring and prepared for sowing. But the preferable practice is to separate the seed from the stalks as soon as the latter have become sufficiently dry for the purpose, both because the hay is rendered almost useless by being stacked up with the seed, and thrashed in spring when it is very brittle, and because the seed itself is more liable to heat in the stack than in the granary, where it can be noticed and turned over as often as necessary. The thrashing, which is always done with a light flail, may be performed in the field, and the hay made into cocks for further drying; or the ryegrass may be carted to the stackyard, and there thrashed on a strong door, placed upon a winnow cloth, similar to that used in rippling flax. The seed is then conveyed in sacks to the granary, and laid thinly on the floor to dry. It is to be regularly turned over at least once a day to prevent fermentation, the least degree of which would be fatal to the vegetative powers of the seed. When sufficiently dry, it may be winnowed, measured, again spread rather thickly on the granary floor, and protected from the depredations of vermin. The seed is again slightly winnowed in spring immediately before being required for use, to free it of dust and all impurities. When ryegrass is cultivated expressly for seed, from 25 to 30 bushels are often obtained per acre. The hay is of course of an inferior quality, and the land considerably exhausted in consequence of allowing the crop to mature its seeds.

RYELAND SHEEP. See Sheep.

S

SABAL. A genus of small, beautiful, tropical palms. Five species of it occur in the palm-houses of Britain. It is nearly allied to the genus Corypha. See the article Fan-Palm.

SABBATIA. A genus of ornamental, herbaceous plants, of the gentian family. Several species, principally biennials of from 6 to 15 inches in height, with red or purple flowers, have been introduced to Britain from North America; and will thrive on any common garden soil.

SACCHAROMETER. An instrument for ascertaining the proportion of sugar which any liquid contains. It is useful in brewing and wine-making and similar processes. A number of kinds of it, and also a number of substitutes for it, are in use. The practical point is simply to determine the specific gravity of the wort or other liquid.

SACCHARUM. The sugar cane genus of grasses. It belongs to the villiflorous tribe; but has a structure and habit similar to the reeds. About 10 or 12 species of it have been introduced, as curiosities, to the hothouse collections of Britain; and at least 20 other species are

known. Several of the species are cultivated, in various hot parts of the world, for the production of sugar; and a number are useful for reed-pens, for thatch, for railings, for rafts, and for other economical purposes.

The officinal species, or common sugar-cane, *Saccharum officinarum*, concentrates in itself the main interest of the genus, and affords, at the same time, a good specimen of the species. It is a native of the East Indies, the West Indies, and some of the tropical parts of Continental America; it was introduced to British gardens from India toward the close of the 16th century; it seems to have been first cultivated by the Spaniards in their country, and to have been carried back thence, as an economical plant, to the West Indies and Brazil; and it is now abundantly cultivated in the West Indies, in Persia, and on the islands and sea-boards of the Indian Ocean. The root is jointed; several stems rise from each root, and are jointed, and commonly attain a height of from 8 to 14 feet; a leaf springs from each cauline joint, and sheaths the stem up to the next joint, and there expands out to a length of 3 or 4 feet, with a narrowness proportionate to the shape of a blade of grass, and with thin and sharply toothed edges; the flowers grow in terminal panicles of two or three feet in length, and have thin florets enclosed in long flexuose down; and the seeds are oblong and pointed, and ripen in the valves of the flowers. In the West Indies, the plant is propagated from cuttings, and does not ripen in less than from 14 to 17 months, but is cut for making sugar between the 6th and the 13th month, when the culms are from 7 to 10 feet high, and have a smooth, dry, and brittle cuticle; and, in good, rich, permeable soil, it commonly yields five crops of shoots before requiring to be repropagated. In British hothouses, it is propagated from slips or suckers, and grown in pots, filled with rich garden earth, and plunged in a moderate hotbed of tanner's bark. See the article Sugar.

SACCOLABIUM. A genus of ornamental, tropical, epiphytous plants, of the orchis family. The name signifies "sack lip," and alludes to the form of the labellum. The pimpled species, *S. papillosum*, was the earliest known in Britain, and was introduced hither about 20 years ago from India; and it has a white spotted flower, and blooms in autumn. The gemmed species, *S. gemmatum*, was introduced 8 or 9 years later, and carries pink and white flowers in May, and possesses a high degree of beauty. Some other species have been introduced.

SACK. A large canvas bag for holding grain, pulse, small seeds, and other similar farm produce. A number of sacks, proportioned to the quantity of produce likely to be sent to market, ought to be kept ready for use, and in sound and clean condition, on every farm. They may be made, more or less strong, and of either plain or tweeled sacking, according to the particular purposes for which they are to be employed; and all should be marked with the initials of the owner or with the name of the farm. When any become wetted, they must be shaken and dried; or when dirtied with mud, they must be washed; or when holed, they must be patched or darned;—and all should be kept stored away in some dry airy place, such as upon ropes across the granary.

SACK-BARROW. See Barrow.

SACRED BEAN. See Nelumbium.

SADDLE. The artificial seat of a rider upon a mule's or horse's back. It should be so constructed as to combine comfort to the rider with ease to the horse. It ought to press only on the back, and on neither the spine nor the withers; it must make everywhere an uniform pressure, and must neither tilt forward upon the points nor jut backward upon the seat; and, when fully adjusted and fastened on the animal, it should have as large a free space beneath the pommel as will permit the introduction of the hand. If these matters, and some others which are well-known to all duly qualified saddlers, are not fully attended to in the construction of any saddle, not only discomfort to the rider but much suffering and serious disease to the horse may be the consequence.

SADDLE-BACKED. See Back.

SADDLE-GALL. See Gall.

SADDLE-GRAFTING. See Grafting.

SAFFLOWER. See Carthamus.

SAFFRON. The prepared stigmas of the *Crocus Sativus*. This plant grows wild in the meadows of some parts of England, and is commonly classed as indigenous, but probably was introduced at some remote period from Greece or Asia. Its root is perennial, and comprises a solid and depressed bulb; its flower is sessile on the bulb, and rises before the leaves on a long, slender, white tube, and has a rich violet or lilac colour, and blooms in September and October; its stigma is pendulous, odorous, and deeply three-cleft, and has a brilliant orange colour; and its leaves are linear, somewhat revolute, and have a deep rich green colour, veined with a white line along the centre, and are enclosed with the tube of the flower in a membranous sheath.

"For the preparation of the saffron, the flowers are gathered early in the morning, just as they begin to open. They are then spread upon a table, and the pistils are carefully picked out of the flower, they being the part containing the saffron; the rest of the flower is useless. They are then dried upon a portable kiln, of a peculiar construction, over which a hairy cloth is stretched, and over this several sheets of white paper are laid, upon which the wet saffron is spread between 2 and 3 inches thick. It is now covered with other sheets of paper; and over them is laid a coarse blanket 5 or 6 times doubled, which is pressed down with a board and large weight,

after the fire is lighted. The first heat is strong, in order to evaporate the moisture; after an hour, when it is formed into a cake, it is turned, and the same degree of heat continued for another hour. The fire is then reduced, and a moderate heat kept up for 24 hours, during which time the cake is frequently turned in order to dry it thoroughly; this having been accomplished, it is fit for the market." The finest saffron, however, consists simply of the dried stigmas, and is not formed into a cake, and bears the name of hay saffron.

The cultivation of the saffron crocus was practised in very ancient times. The Greeks and the Romans made use of saffron for perfuming halls and theatres, for scenting salves and balsams, and for seasoning dishes; and the latter people sent to the Levant for it in early times, before they had learned to cultivate it for themselves. The cultivation of it is supposed to have been introduced to England at the time of the Crusades; and was long carried on in Essex, particularly in the vicinity of Saffron-Walden, to which it gave its name; and was conducted also in Cambridgeshire, Herefordshire, and Suffolk, but eventually became confined to Stapleford. The saffron of the market is supplied from England, Sicily, France, and Spain. The English is the best; and the Spanish is the worst, being generally injured with oil in which it has been dipped to ensure its keeping. But all cake saffron is occasionally or even often adulterated with intermixtures of the fibres of dried beef, or of the petals of the safflower, the golden thistle, and the common marigold; and it may be tested by infusing a piece in hot water, when the true saffron or expanded stigmas will become easily distinguishable from the intermixed ingredients.

The soil most suitable for the cultivation of saffron is rather rich and of medium texture. The bulbs should be planted in June, at distances of 6 inches from row to row, and of 3 inches from bulb to bulb; and the crops are taken, year after year, simply by gathering the flowers when they expand. One plantation should generally stand for three years; and, at the end of that time, the bulbs should be taken up, and a new plantation formed. Miller computes the average produce per acre of dried saffron, at about 2 lbs. for the first year, and 24 lbs. for the two subsequent years, — the quantity in the third, however, being considerably greater than that in the second.

Saffron is used both in medicine and as a dye. It has a sweetish penetrating odour, a bitterish warm taste, and a rich, deep, red orange colour. It acts as a stimulant and antispasmodic, but is liable, in large doses, to produce convulsive laughter and some dismal consequences; and is seldom given, in modern practice, except as a qualifying principle of other medicines. The colouring principle of it is soluble in water and alcohol, and is of itself a bright yellow, but becomes first blue and then lilac by the action of sulphuric acid, and green on the addition of nitric acid; and in allusion to the great diversity of tints which it assumes under different circumstances, it has been called Polychroite.

SAFFRON (Bastard). See Carthamus.

SAFFRON (Meadow). See Colchicum.

SAGE,—botanically *Salvia Officinalis*. A hardy, evergreen, economical undershrub, of the labiate order. It is a native of the south of Europe, and was introduced to Britain toward the close of the 16th century. Its stem is quadrangular, branching, bushy, and from 12 to 24 inches high; its younger branches are whitish and downy; its leaves stand in pairs on footstalks, and are ovate-lanceolate, crenate, wrinkled, and sometimes of a reddish or purplish tint; and its flowers grow in six-flowered distant whorls, on long terminal spikes, and have a fine blue colour, variegated with white and purple, and bloom in June and July. Some of the chief of many varieties of this plant are the common or red,—the green,—the small-leaved green,—the broad-leaved or balsamic,—the wormwood,—the green, with variegated leaves,—the red, with variegated leaves,—the Spanish or lavender-leaved,—and the painted or party-coloured.

Sage was formerly in extensive use and high reputation as a medicinal plant; and it still holds a place in the Edinburgh pharmacopœia, and in works on medical botany, as a stimulating carminative, and slightly astringent drug; but it has quite lost the confidence of intelligent practitioners, except merely for making a grateful tea, in cases of great nausea, during febrile complaints. It continues, however, to be cultivated in the kitchen garden as an aromatic plant, and for flavouring various dishes. It loves a dry and moderately fertile soil, in a rather sheltered situation; and may be propagated from slips or cuttings, planted in May or June, in dibble-rows, at distances of 6 inches from row to row and from plant to plant. Only the outer and strongest shoots should be taken for cuttings; and the plants, from the time of their becoming fit for use, should be so kept and gathered from as always to have regular bushy heads.

SAGE (Jerusalem). See Phlomis.

SAGITTARIA. See Arrow-head.

SAGAPENUM. A medicinal gum, imported from the Levant. The plant which yields it is supposed to be a ferula; but is not certainly known. The gum has a taste and odour similar to asafœtida, but weaker; and occurs in agglutinated drops or masses, which have a slight translucency, a brownish yellow colour, and a horny fracture. It possesses antispasmodic and emmenagogue properties; and is sometimes administered in the same sort of cases as asafœtida, but does not at all equal that drug in power.

SAGO. The farinaceous pith of a number of endogenous tropical trees. These trees are most plentiful in the islands of the Indian Archipel-

ago; and constitute great forests in the Isle of Ceram; and particularly abound in all the islands which are most favourable to the growth of the clove and the nutmeg trees. The chief species is the *Sagus Rumphii* or *Metroxylon Sagus*, called by the natives the Libby-tree or Libley-tree, a palm of commonly from 30 to 50 feet in height. This tree grows at first very slowly, and has a spinous or thorny armature; but it afterwards grows with great rapidity, and soon attains its full height, and throws off its armature, and acquires a girth of 5 or 6 feet. The exterior part of its trunk is a hard, ligneous tube or cylinder of about 2 inches in thickness; and the interior part, or everything enclosed within the tubular shell, is a farinaceous pith, intermixed with numerous longitudinal fibres. The tree is known to be mature by the transpiration of a whitish dust through the pores of the leaves; and it is then felled, and cut into lengths of 5 or 6 feet. The woody part of one side of each piece is sliced off; a sufficient quantity of the longitudinal fibres and the pith at each end is left to let the whole piece have the form of a trough; all the rest of the interior is cut out; portion after portion of this is returned into the trough, in mixture with water, and there beaten with a spatula or piece of wood; the flour or farinaceous matter has a greater specific gravity than the fibres, and after being separated from them by this beating, is allowed to subside; the water and the floating fibres are then poured off; and the pulp is finally washed several times with clean water, and either granulated by being forced, in a half-dried state, through a kind of funnel, or variously dried and bleached and made to acquire a pearly lustre by means of artificial heat and of warm sifting and half-baking. One tree produces from 2 to 4 cwt. of flour.

The *Sagus Rumphii* was introduced to the palm-houses of Britain, about 48 years ago, from India; and three other palms, constituting with it the genus *Sagus*, or popularly the Sago-Palm genus, were introduced about 20 years later,—the wine-bearing, *S. vinifera*, from Guinea,—and the Ruffia and the pedunculate, *S. ruffia* and *S. pedunculata*, from Madagascar. But sago, similar to that of the *Sagus Rumphii*, is obtained also from the *Saguerus Rumphii*, the *Corypha umbraculifera*, the *Caryota urens*, the *Phœnix farinifera*, and some other palms; and a coarse sago is obtained from the several species of the non-palmaceous cycadeæ. See the article Cycas.

The common sago of commerce has a variable character, and sells much cheaper than the pearl sago, and may easily be imitated by a preparation of potato starch. See the article Potato. Much of the sago of the shops, previous to the removal of the enormous duty which was formerly exacted on its importation, was either partially or wholly adulterated. Pearl sago is a comparatively recent manufacture of the Chinese, and seems to hold some such relation to common sago as refined sugar does to raw sugar. The importation of sago into Britain amounted to only 1,339 cwt. in 1822; and rose to 3,859 cwt. in 1832; and afterwards became so great as to render sago a British bread-stuff, and even an available commodity for the feeding of farm stock.

Sago is the staff of life in the Molucca Islands; and is highly valued as an article of food, for both the sick and the strong, in India. It is but moderately nutritious, consisting chiefly of starch; yet it forms a grateful jelly, and makes an excellent pudding, and combines with three times its weight of wheaten flour to make a palatable, wholesome, and keepable bread. It has long been known, in Britain, as a suitable aliment for infants and for convalescents from acute diseases; and it has been proved, within the last 12 or 15 years, to be admirably adapted for calves, while on milk,—for cows, some time before and after calving,—for young horses in winter, as a substitute for dry corn,—and for young pet lambs, whose mothers have either died or forsaken them. It seems, also, well suited to sporting dogs and to fast-working horses, since it does not affect the wind; and it might be advantageously employed, in all departments of the poultry-yard, as a means of rendering the flesh of fowls more white and delicate for the table. It is commonly used in the state of a jelly; and can easily be reduced to that state with boiling water; but it must either be diluted to the thinness of a drink, or mixed with other ingredients, or beaten up to a comparatively solid consistency, according to the species and the condition of the animals to whom it is given. To a horse after a severe run or burst in the field, about a pound of jelly may be given in complete solution in two or three gallons of warm water; and this will prove a most grateful and refreshing drink. To milch cows, it may also be given dissolved in water as a drink; and it will probably help to give their milk a kernelly flavour. To calves it may be given, in mixture with new milk, as food, in the same proportion as the jelly of lythax or linseed porridge. To pigs, it may be given in drinks, to the amount of two or three pounds to each pig once a-day. To fowls, it should be given in combination with barley-meal, in the form of warm balls. And to dogs, it may be given in the combination of half a pound of sago, boiled to a jelly, and poured over biscuit, bread, or potatoes, previously soaked in milk, and now all beat up in the form of a jelly.

SAINFOIN, or Saintfoin,—botanically *Onobrychis*. A genus of ornamental plants, of the hedysarum division of the leguminous order. It has a five-toothed or parted calyx, and a one-celled, one-podded, thick-skinned, rough-surfaced, crested or winged pod. One species grows wild in Britain; about 20 species have been introduced from other countries; and nearly 20 more are known. Two of the introduced species are

hardy annuals; nearly all the others are hardy, erect, perennial-rooted herbs; and most have a height of about a foot, and carry either purple, pink, yellow, or white flowers.

The indigenous or cultivated species, *Onobrychis sativa*, called by Linnæus *Hedysarum onobrychis*, concentrates in itself the main interest of the genus, and commonly makes a complete monopoly of the name, and at the same time occupies the rank of an important agricultural plant. It grows naturally on light chalky soils in various parts of England; yet is said to have been originally introduced as an agricultural plant from France. It formerly bore the popular English name of cock's head; but is now known among farmers only by its French name of sainfoin or saintfoin, signifying "holy hay." Its roots are subfusiform and perennial, and are capable of penetrating to a very great depth; its stems are recumbent, yet not far from upright, and have commonly a length of two or three feet; its leaves are pinnate and smooth; its leaflets amount to from 9 to 15 on each leaf, and are opposite and acute; its flower-stalks are axillary, ascending, and longer than the leaves; its flowers grow in dense tapering spikes at the top of the flower-stalks, and have a beautiful variegated pink colour, and bloom in June and July; the wings of the flowers are about as long as the calyx; and the pods are erect and toothed at the margin and ribs. A variety called *O. s. bifera* grows faster and blooms earlier than the normal plant.

Sainfoin has long been cultivated in France and other parts of Continental Europe; and began to be cultivated in Britain about the middle of the 17th century; and is now regarded as the most valuable leguminous forage plant on the dry, thin, chalky and gravelly soils of the South of England, and as at the same time peculiarly suitable for poor, dry, non-gramineous soils of other districts. It chiefly serves for hay; and thrives well on lands which naturally yield little grass, and are not fit for being constantly under tillage. But, in most respects, it so closely resembles lucern, in at once nature, qualities, and treatment, that very little requires to be said respecting it different from what we have said respecting that plant. See the article Lucern.

Sainfoin requires a dry situation for its roots; and is fond of calcareous action; and has the power of sending down its rootlets, through rubble or through the crevices of rocks, to the depth of 15 or 20 feet, in search of sufficient support or nourishment; and cannot long thrive in any soil whose surface becomes matted or even considerably occupied with grasses or spreading weeds. It luxuriates on almost any dry chalky soil, or on any open and poor land which has a calcareous substratum, within a reachable depth; but will not thrive in mere sands or gravels, unless they receive a large artificial intermixture or dressing with lime; and has little or no repugnance to natural richness of soil, except in so far as the free ranging of its roots may be hindered, or the growth of grasses and weeds encouraged.

The preparation for sainfoin ought not to comprise any manuring, and should consist simply in thorough cleaning and in deep and minute pulverization. It comes very appropriately at the close of an alternate rotation of seven or eight crops; and it may be sown either broadcast or in drills,—either alone or with a corn crop, in the same manner as the clovers and grasses. The broadcast sowing is preferable to the drilling. The seeds are large, and require to be more deeply covered than those of clover, and may be ploughed in with a very shallow furrow. About four bushels per acre are required for broadcast sowing; and about three for drilling. A sowing with barley or other grain, to about half the amount of seed which would be requisite for a full crop of it, is much better than sowing the sainfoin alone; for the corn shades the sainfoin and keeps it moist during the first summer, and at the same time is not thick enough to injure it by a crowding of the soil or by an undue abstraction of nourishment. When broadcast sowing is preferred, the corn should be sown first, and once harrowed, and the sainfoin sown after and lightly rolled; and when drill-sowing is preferred, the drills for the corn should run in one direction, and those for the sainfoin in a cross direction or at right angles.

Sainfoin attains its full growth in about three years, and usually begins to decline on sandy or gravelly soils in seven or eight years, and on chalky soils in from eight to ten years. But though thenceforth losing vigour, it has been known, in a neglected state, to exist 50 years, and even nearly 100 years. It may also be prolonged in vigour, and likewise rendered increasingly luxuriant in its earlier years, by the judicious application of suitable top-dressings. On deep loamy soils, along the skirts of chalk hills, indeed, no top-dressing should be given; but on thinner and poorer and colder soils, a top-dressing of 5 bushels per acre of gypsum, or of 10 or 12 bushels of peat ashes, or of 30 bushels of coal ashes, once a-year or once in two years, according to circumstances, will generally prove highly beneficial. The grand enemies to the duration of sainfoin are the grasses and the creeping weeds, which form a close turf and choke up the crop; but these cannot be controlled any further than by the selection of a soil which is naturally unfavourable to them, or by the hoeing of a drilled crop in the next season after sowing.

Sainfoin makes excellent hay; and is chiefly valued for that purpose. It should be cut when in full bloom, and so managed as to retain, in its dried state, the natural hue and form of the flowers, and the clear full verdure of the stems and the leaves. It is treated, in a general way, in the same manner as other hay plants; but it requires very particular care, and is specially

susceptible of injury from humidity in the atmosphere, and may both lose all its fragrance and be rendered exceedingly difficult to dry by a drenching rain. A cutting of it upon any thin calcareous soil, is generally both richer in quality and greater in quantity than a first cutting of clover. But it seldom admits of being profitably cut a second time in one year; and the after-grass of it is commonly depastured by horses and cattle. Sheep have a keen relish for it; but, in consequence of their eating it very closely down, they must not have access to it at a late period of the year, lest they should leave its root-crowns too bare to resist the killing action of the winter's frost.

Sainfoin plants intended for seed should remain untouched till their husks become somewhat brownish, and their seeds become quite plump and firm; and, as they ripen very unequally, and are exceedingly ready to shed their seeds, they should be cut while the dew is on them, and not turned or touched in the swathes, if possible, till they become sufficiently dry; and they may then be either thrashed out on cloths in the field, or carried away with all possible gentleness to a thrashing machine. The seeds, after being thrashed out and cleaned, should be spread closely upon a boarded floor, and left there till they become so thoroughly dry as to escape all risk of fermenting. The breaking up of sainfoin land may be effected by scuffling out the roots and weeds and afterwards burning them; but is more easily done by paring and burning. See the article Paring and Burning.

SAINFOIN,—botanically *Astragalus Onobrychis.* A beautiful, hardy, perennial-rooted, herbaceous plant, of the milk-vetch genus. It was introduced from Austria to Britain before the middle of the 17th century. Its stems are procumbent or trailing and about 20 inches long; and its flowers are densely capitate, and have a purple colour, and bloom in June and July. It forms the type of a subgenus of the milk-vetches.

SAINT BARNABY'S THISTLE. See Centaurea.

SAINT JOHN'S WORT. See Hypericum.

SAINT PETER'S WORT,—botanically *Symphoria.* A genus of hardy, ornamental, deciduous, North American shrubs, of the honeysuckle family. The glomerated species, *Symphoria glomerata,* called by Linnæus *Lonicera symphoricarpos,* is the type of the genus; and takes its botanical names from the clustered arrangement of its fruit. It is a native of Virgina and Carolina; and was introduced to Britain in 1730. It has commonly a height of about 4 feet. Its main stems are ragged, and have a dirty dark brown colour; its branches are numerous and generally short,—yet some are slender, trailing, and long; its leaves are very numerous, oval, and about half an inch long, and stand opposite on exceedingly short footstalks, and constitute an aggregate rich foliage, and die away in autumn to a dark-brown colour; and its flowers grow round the stalks, and are small and inconspicuous, and bloom in August and September. A variety occurs with variegated leaves. Four or five other species, all similar in height to the glomerated, have been introduced.—St. Peter's wort is also the popular name of a hardy, perennial-rooted, yellow-flowered, herbaceous species of hypericum.

SAL AMMONIAC. The muriate of ammonia. It is a product of volcanoes; and was formerly imported to Europe from Egypt, where it was obtained by sublimation from the soot of camel's dung; and is now manufactured in Britain and on the Continent by the mutually decomposing action of sulphate of ammonia and either muriate of soda or muriate of magnesia, and by other and preceding and widely different processes. It is commonly formed into hemispherical, whitish, elastic cakes, of about two inches in thickness. It has a pungent saline taste, but has not any smell. It has a specific gravity of 1·45; and slightly attracts moisture from the atmosphere; and is soluble in 3¼ times its own weight of water at 60° Fahrenheit; and sublimes at a high temperature, without melting or becoming changed. It consists of one equivalent of muriatic acid, and one equivalent of ammonia. This salt was formerly regarded as a powerful internal remedy in both human and veterinary medicine; but it is now scarcely ever used except externally and in mixture with other substances; and it acts principally as a refrigerant and a discutient. See the article Ammonia.

SALEP. See Orchis.

SALICARIA. See Lythrum.

SALICIN. A peculiar principle found in the bark of the aspen and of several species of willow. It was first discovered by M. Leroux, in 1830, in the bark of the *Salix helix.* It is separated by chemical reagency from a watery decoction; and it forms in perfectly white, delicate, acicular or prismatic crystals. It has a very bitter taste; and is sparingly soluble in cold water; and possesses neither acid nor alkaline properties; and consists of two equivalents of carbon, two of hydrogen, and one of oxygen. It has similar medicinal virtues to quinine.

SALICORNIA. See Glasswort.

SALISBURIA. An ornamental, hardy, deciduous, small tree, of the amentaceous order. It constitutes a genus of itself; and is specifically called *adiantifolia* or the maiden-hair-leaved. It has highly curious and very exotic-looking foliage; and, on that account, is entitled to a place on every lawn, and makes an interesting appearance in every collection of hardy shrubs. It is a native of Japan; and was introduced to Britain in 1754. It loves a soil of sandy loam; and is propagated from cuttings; and commonly attains a height of about 20 feet; and blooms in April and May.

SALIVA. The fluid secreted within the mouth of animals. It forms spittle, and is of main use

in keeping the mouth moist, and in softening and empulping food during mastication. It is secreted partly by the parotid gland, situated below and before the ear,—partly by the submaxillary glands, situated under the jaw,—partly by the sublingual glands, situated under the tongue,—and partly by a number of small glands, situated on every part of the mouth, cheek, and lips. These glands, especially the principal ones, bear the name of salivary glands; and are liable to inflammation and swelling from catarrh; and occasionally become the seat of concretions, consisting chiefly of carbonate of lime. Saliva contains about 99·3 per cent. of water, and 0·7 of very complicated and somewhat variable solid matter. The saliva of man contains very little carbonate of soda; but that of sheep contains so much, that it effervesces with acids. The solid matter of saliva, in general, contains a large proportion of muriate of potash, much smaller proportions of the sulphate, the carbonate, the acetate, and the sulphocyanate of potash, and a minute quantity of some animal principle which some chemists suppose to be osmazome.

SALIX. See Willow, Osier, and Sallow.

SALLENDERS. See Mallenders.

SALLOW. Species of willow which are not flexible like osiers, but which form rough bushes or large trees. A number of different kinds of sallows grow wild in the hedges, and moist grounds, and marshy woods of Britain; and are useful for various economical purposes, and afford material for making the best kind of charcoal. See the article Willow.

SALLOW-THORN. See Buck-Thorn (Sea).

SALMON,—*salmo salar*,—a celebrated fish belonging to the trout genus, which inhabits the northern seas, and ascends the rivers in spring for the purpose of depositing its spawn. The excellence of its flesh is well known, but it varies somewhat in different waters. In certain districts, the abundance of this fish forms a great source of wealth to the inhabitants, and it often forms a chief article of sustenance. The salmon inhabits the European coasts, from Spitzbergen to Western France, but is never seen in the Mediterranean. On the western shores of the Atlantic it is found from Greenland to the Hudson, but is exceedingly rare in the latter river, and never penetrates father south. It ascends the St. Lawrence to lake Ontario, and enters the tributaries of that lake; but the fall of Niagara presents a barrier to its further progress into the continent. In the North Pacific the salmon again makes its appearance, and frequents, in vast numbers, the rivers of North-western America, Kamtschatka, and Eastern Asia. A cold climate and clear water seem to be most congenial to its constitution. The salmon grows to the length of about four feet, and usually attains a weight of from 30 to 70 pounds. The body is elongated and compressed; the colour silvery-grey, with spots; the head of moderate size, and the upper jaw rather the longest. Almost all parts of the mouth, and even the tongue, are furnished with pointed teeth, as in the other trouts, and, like them, it has an adipose fin upon the lower part of the back. All the trouts are voracious and carnivorous, and in general seek the purest water. As soon as the ice melts, the salmon enters the mouths of rivers, and, as has been ascertained, almost always of those which gave them birth. They swim usually in immense bodies, in the middle of the stream, and near the surface: their progress is slow, and they make a great noise in sporting, if the weather be fine. They are easily frightened, either by a sudden noise or floating timber, and on such occasions sometimes turn aside from their course and return to the sea. When farther advanced, they make the most determined efforts to surmount rapids and cascades, and will leap a fall of twelve or fifteen feet in perpendicular height. If alarmed, they dart away with such rapidity that the eye can scarcely follow them. The velocity of this motion has been proved to equal twenty-five to thirty miles per hour. They penetrate far into the interior of the continents, and deposit their spawn in the lakes, &c., about the head-waters of the longest rivers. When the young are about a foot in length, they descend the rivers and take refuge in the ocean. Late in the following spring or in the beginning of summer, and after the old ones have ascended, the young again enter the rivers, and are then about eighteen inches in length. They again seek the ocean on the return of frosts. At two years old, the salmon weighs six or eight pounds; and it requires five or six years to attain the weight of ten or twelve. The salmon-fishery is one of the most important branches of business in the north of Europe. Immense quantities of this fish are taken every year, and form a considerable accession to the general mass of nutriment. The flesh is bright orange, but, though delicious to the taste, and very much sought after, is difficult of digestion.

SALPIGLOSSIS. A genus of ornamental, exotic plants, of the nightshade family. They first became known in Britain in 1824; and they came rapidly and generally into notice among all classes of florists. They are principally annuals of from 12 to 30 inches in height; and are remarkable for diversity of colour, and for a singular sportiveness and instability of character. Any single sowing, even without any attempt being made to intermix pollen, may produce many varieties in both shape and colour. Some of the kinds most generally esteemed—for whether they be species or varieties cannot easily be determined—are those called *S. picta*, *S. hybrida*, *S. atropurpurea*, *S. cærulea*, and *S. Barclayana*, the first two with violet flowers, and the others with respectively purple, blue, and yellow flowers.

SALPIXANTHA. A genus of ornamental,

exotic plants, of the acanthaceous order. The scarlet species, *S. coccinea*, was introduced a few years ago from Jamaica to the stoves of Britain; and is a low branching shrub, of very great beauty. Its leaves are opposite, peduncled, and ovate; and its flowers grow in loose, graceful, axillary, and terminal spikes, and stand out from them in opposite pairs, and have a tubular shape with expanding margin, and are scarlet without and white within, and bloom in autumn and the early part of winter.

SAL PRUNELLE. See NITRATES.

SALSAFY, or SALSIFY,—botanically *Tragopogon Porrifolius*. An ornamental, culinary, indigenous, biennial, herbaceous plant, of the goat's-beard genus, and of the succory division of the composite order. It grows wild in the moist meadows of some parts of England; and has long been cultivated in kitchen gardens. Its roots are long, white, and fleshy; its stems are smooth, tender, and about 4 feet high; its leaves are leek-like and comparatively broad; its calyx is longer than the florets or floral rays; and its flowers have a dull purple colour, and bloom in May and June. Its roots have a mild and sweetish flavour, and are boiled and eaten like carrots; and its young shoots are dressed and used in the manner of asparagus. It loves an open situation, and a deep soil of rich mould; and may be raised from seed sown at any time from March till May, either broadcast in beds, or in small drills 8 or 10 inches apart. The young plants, when 2 or 3 inches high, must be thinned out to distances of 6 inches; and the beds or drills must be occasionally watered. The roots will be fit for gathering from August till October; and the young shoots, in the following spring.

SALSILLA. See LILY (EATABLE ROOTED).

SALSOLA. See SALTWORT.

SALT. This term was originally employed to denote *common salt*, but was afterwards generalized by chemists, and employed by them in a very extensive and not very definite sense. They understood by it any body which is sapid, easily melted, soluble in water, and not combustible; or a class of substances midway between earths and water. Many disputes arose concerning what bodies ought to be comprehended under the designation, and what ought to be excluded. Acids and alkalies were allowed by all to be salts; but the difficulty was, to determine respecting earths and metals; for several of the earths possess all the properties which have been ascribed to salts, and the metals are capable of entering into combinations which possess saline properties. The old chemists, however, eventually restricted the term salt to three classes of bodies,—*acids, alkalies,* and the *compounds* which acids form with alkalies, earths, and metallic oxides. The salts of the first and second of these classes were called *simple salts;* and these of the third class were called *compound* or *neutral*. This last appellation originated from an opinion long entertained by chemists, that acids and alkalies, of which the salts are composed, were of a contrary nature, and that they counteracted one another; so that the resulting compounds possessed the properties neither of acids nor of alkalies, but properties intermediate between the two. The chemists of a later period restricted the term *salt* still more, by tacitly excluding acids and alkalies from the class of salts altogether; and the definition of it then came to be,—a definite compound of an acid and a base, each comprising at least two elementary substances; and though this definition excludes the whole group of what are called haloid-salts, and does not accord with the theories of some of the principal modern chemists, it is still, and perhaps will long continue, the most convenient for all popular and practical purposes.

The acid constituent of a salt may possess any degree of sourness, from an absolute negation of it up to the most mighty corrosiveness; and the basic constituent may be either an alkali, an alkaline earth, or a metallic oxide. Some salts, such as Epsom salt and Glauber's salt or sulphate of magnesia and sulphate of soda, are readily recognised by all persons as true salts; but others, such as marble, gypsum, bone earth, and flint glass, or carbonate of lime, sulphate of lime, phosphate of lime, and the double bisilicate of potash and bisilicate of lead, are thought by untutored observers to be totally different from salts. Yet the constitution of the latter is formed on exactly the same type as the former; bone earth, for example, being a compound of the corrosive oxygen acid of phosphorus and the earthy alkaline oxide of calcium, just as Epsom salt is a compound of the corrosive oxygen acid of sulphur and the earthy alkaline oxide of magnesium. Haloid salts, on the other hand, possess a truly salt-like appearance, but differ widely from all true salts in constitution; they comprise all the metallic chlorides, iodides, and fluorides, and are closely akin in nature to the oxides and the sulphurets; and they take for their type, the chloride of sodium or common salt, which consists merely of the two elements chlorine and sodium, and whose Greek name, together with a word signifying 'form,' furnishes the epithet haloid.

The new theory regards common salt as the type, not only of the haloid salts, but of all salts whatever; it views common salt as formed by the metal sodium taking the place of the hydrogen of hydrochloric acid; it supposes every acid to be ultimately or really a hydrogen one, and every salt of each acid to be formed by a metal taking the place of its hydrogen; and in order to make out its data, it ascribes all the oxygen of saline compounds to their acids, and denies that any of these acids are hydrates. In the case of the alkaline and the earthy sulphates, for example, it affirms that they contain, not the alkalies and the oxides themselves, but only their

respective metals; that they are formed, not by the alkalies and the oxides taking the place of the water of a hydrated sulphuric acid, but by the metals of these bodies taking the place of the hydrogen of a dry or anhydrous sulphuric acid; that they arise, not out of an acid compound of one equivalent of water and one equivalent of a body consisting of one atom of sulphur and three atoms of oxygen, but out of an acid compound of one equivalent of hydrogen and one equivalent of a body consisting of one atom of sulphur and four atoms of oxygen; and that, therefore, they differ from common salt only in having a compound radical, sulphur and oxygen, instead of the simple radical chlorine,—a body which, after all, may possibly prove to be as really a compound as the analogously acting body, cyanogen. "It may be stated," says Dr. Gregory, "that although the body consisting of one atom of sulphur and three atoms of oxygen exists, it is not truly an acid, and does not acquire acid properties until it has been in contact with water, and combined with it, that is, with hydrogen; that, with ammonia, this body does not form sulphate of ammonia, but an entirely different compound; that, although the supposed radical, consisting of one atom of sulphur and four atoms of oxygen, is unknown in a separate form, the same objection may be made to the older view in the case of nitric acid and many other acids,—for strong nitric acid is viewed as a hydrate of dry nitric acid, while dry nitric acid is quite unknown in a separate form; that those oxygen acids which exist without hydrogen, such as dry sulphuric acid, dry phosphoric acid, carbonic acid, silicic acid, and chromic acid, either have no acid properties till water is added, as in the case of dry sulphuric acid and dry phosphoric acid, or possess very feeble and ill-marked acid properties, as in the case of carbonic and silicic acids, which cannot neutralise the alkalies, and form with them an almost unlimited number of compounds; and that all those oxygen acids which possess in perfection the acid character, such as oil of vitriol, nitric acid, phosphoric acid in its active state, and the whole of the organic acids, invariably contain hydrogen in a form in which it is replaced by metals in the salts, or, according to the older view, water, which in the salts is replaced by metallic oxide. Now, as in water and metallic oxide, the oxygen is the same, it is, even on that view, hydrogen which is replaced by metal, when an acid is converted into a salt. It may be added, that considerations derived from the phenomena of galvanic decomposition, from the heat developed when bodies combine to form salts, and from the molecular or atomic volume of acids and salts, all concur to render it probable that oxygen acids are hydrogen compounds, not hydrates, and that oxygen salts contain a metal united to a radical, and not an oxide united to a dry or anhydrous acid."

The old theory, however, though less consistent and far less beautiful and less simple to the well-informed chemist than the new one, is really plainer and more useful to the farmer and the general thinker; it also figures exclusively in all the best chemical works down to a very recent period, and at the same time occupies a place by the side of the new theory in the formulæ of even the most recent chemical writings; and it has far too firm a hold of both the nomenclature and the discussions of general chemistry, whether in itself or in its connexions with agriculture, to be conveniently shaken off by any but complete adepts in chemical science. It likewise offers an easy rule for classifying all the true salts, according to either their base or their acid, or for readily comparing the saline combinations of each complicated acid, and those of each oxide and of each alkali, as well as those of each simple acid and those of each metal; and it conveniently leaves all other salts than the true ones to be arranged into the two supplemental groups of haloid salts and sulphur salts.

The groups of true salts, as arranged according to their acids, need not amount to more than six, and yet possess very distinct characters of classification. One group comprises the sulphates, sulphites, hyposulphates, and hyposulphites; a second comprises the nitrates, the nitrites, the chlorates, the iodates, and the bromates; a third comprises the phosphates, the pyrophosphates, the metaphosphates, the phosphites, the arseniates, and the arsenites; a fourth comprises the chromates, the borates, and the fluo-borates; a fifth comprises the carbonates; and a sixth comprises the hydrochlorates, the hydriodates, the hydrobromates, the hydrofluates, the hydrosulphates, the hydroselianates, the hydrocyanates, the ferrocyanates, and the sulphocyanates. Haloid salts, in addition to simple haloids, comprise acid haloids, each composed of a simple haloid and the acid of its radical, and also oxyhaloids, each composed of a simple haloid and an oxide of the same metal as its base. Sulphur salts are double sulphurets, and present a pretty close resemblance to true salts; and they have been classified into hydrosulphurets, carbo-sulphurets, arsenio-sulphurets, and molybdo-sulphurets. The total number of known salts amounts to several thousands; and the proportion of these which play a conspicuous part in the natural chemistry of the soil, and of manures, and of vegetation, and of the animal functions, is very great. Some salts combine with one another, so as to form double salts; and they may consist either of one acid and two bases, or of two acids and one base, or of two acids and two bases; but the great majority consist each of one acid and two bases.

The early names of the salts, so far as these bodies were known to chemists, were wholly destitute of scientific precision. At present, however, they are universally designated according to the nomenclature of Morveau. The name of each

salt consists mainly of two words, one generic, the other specific. The generic word precedes the specific, and is derived from the acid; the specific comes from the base. For example, a salt consisting of *sulphuric acid* and *soda*, is spoken of generically under the name of a *sulphate*, and specifically, by adding the name of the base; thus, *sulphate of potash*. The termination *ate* corresponds with the acid whose termination is in *ic*, and the termination *ite* with the acid whose termination is in *ous;* thus *sulphuric* acid gives *sulphates,—sulphurous* acid, *sulphites*. There are some acids containing less oxygen than those that terminate in *ous:* in such case, the word *hypo* is prefixed; thus we have *hypo*-sulphurous acid, *hypo*-nitrous acid, giving also salts that are called *hypo*-sulphites, and *hypo*-nitrites. When the salt is a compound of one atom, or proportional of acid with one of base, it is distinguished simply by the words denoting the acid and the base, without the addition of any prefix. If the salt contains *two* atoms of acid united to *one* atom of base, the Latin numeral adverb *bis* or *bi* is prefixed. Thus *bisulphate of potash* is a salt composed of two atoms sulphuric acid and one atom potash. Were there three, four, &c., atoms acid, the numeral adverbs *ter*, *quater*, &c., would be prefixed. Thus *quateroxalate of potash* means a compound of four atoms oxalic acid and one atom of potash. When two atoms of base are combined with one atom of acid, this is denoted by prefixing the Greek numeral adverb *dis*. Thus *diphosphate of potash* means a compound of two atoms potash with one atom phosphoric acid. The prefixes *tris*, *tetrakis*, &c., indicate three, four, &c., atoms of base with one atom of acid. Salts of this description were formerly termed *sub-salts;* at least in those instances where an alkaline reaction was produced upon test-liquors from the excess of base.

All salts, with a very few exceptions, are solid; and most either have naturally the form of crystals, or assume that form by the slow evaporation of their aqueous solutions. Some are soluble in water, and more or less sapid; and others are insoluble and completely insipid. One, the carbonate of ammonia, emits an exceedingly pungent odour, and has popularly the name of smelling salt; but almost all the others are totally odourless. Some have brilliant colours, and others have none; and some are transparent, others semipellucid, and others opaque. All which consist of a colourless acid and a colourless base, are themselves colourless; and some also which consist of a coloured acid or a coloured base are colourless; and many which consist of coloured constituents and are themselves coloured, possess entirely different colours from those of their constituents. Some have a powerful affinity for water, and attract so much moisture from the atmosphere as to deliquesce or become liquid; others remain unchanged under a dry atmosphere, but become moist under a humid one; and others show such indifference or resistance to water as to suffer no change from exposure to an atmosphere loaded with vapour. Some of the soluble salts dissolve in less than their own weight of water; and others do not dissolve in less than dozens or scores or even hundreds of times their own weight of water. Many salts, in the process of crystallizing, combine with themselves a definite portion of water, which is essential to their crystalline state, and bears the name of the water of crystallization; and some of these contain more than half of their own weight of this water, and yet are perfectly dry,—all lose the whole of their water when exposed to a strong heat,—and some, such as the sulphate of soda and the phosphate of soda, lose a portion of their water and crumble down into powder, or are said to effloresce, when merely exposed for some time to the air. Salts which do not take water freely into combination with their crystalline constitution, often enclose particles of it among the interstices of their crystals; and when heated, they are rent asunder by the expansion of these particles, and in consequence burst with a crackling noise, and are said to decrepitate. Several different salts which do not decompose one another may be held in solution by the same quantity of water which is merely sufficient to dissolve one; and, in some instances, two different salts, in consequence of their mutual combination, are soluble in less water than would suffice for the separate solution of either. Most salts produce cold during the process of solution; and those which contain water of crystallization produce more than those which contain none; and any produce more when dissolved rapidly and in large quantity than when dissolved slowly and in small quantity. All salts, either in a state of solution or in a merely moistened state, are decomposed by voltaic electricity.

The solubility of the soluble salts in water is one of their most important general properties. In this menstruum they are generally crystallized; and by its agency they are purified and separated from one another, in the inverse order of their solubility. The determination of the quantity of salt which water can dissolve, is not a very difficult process. It consists in saturating the water exactly with the salt, whose solubility we wish to know, at a determinate temperature, weighing out a certain quantity of that solution, evaporating it, and weighing the saline residue. We shall give the results of some experiments upon the solubility of a few salts.

Sulphate of Soda.

Temperature.	Salts soluble in 100 parts of water. Anhydrous.	Crystallized.
0·00°	5·02	12·17
11 67	10·12	26·38
17·91	16·73	48·28
28·76	37·35	161·53
30·75	43·05	215·77
32·73	50·65	322·12

40·15	48·78	291·44
50·40	46·82	262·35
59·79	45·42	
70·61	44·35	
84·42	42·96	
103·17	42.65	

Hence it appears that the solubility of sulphate of soda follows a very singular law. After having increased rapidly to about the temperature of 33°, where it is at its maximum, it diminishes to 103·17°; and at that point it is nearly the same as at 30·5°.

Solubility of Chloride of Potassium.

Temperature.	Salt dissolved in 100 water.
15·64°	43·50
49·31	55·63
74·89	65·51
105·48	77·89

Solubility of Chloride of Sodium (Common Salt).

Temperature.	Salt dissolved in 100 water.
13·89°	35·81
16·90	35·88
59·93	37·14
109·73	40·38

Solubility of Sulphate of Magnesia (Epsom Salt).

Temperature.	In 100 water.
14·58°	103·69
39·86	178 34
49·08	212·61
64·35	295·13
97·03	644·44

Solubility of Nitrate of Potash (Nitre).

Temperature.	Salt dissolved in 100 water.
0·00°	13 32
5·01	16·72
11·67	22·23
17·91	29·31
24·94	38·40
35·13	54·82
45·10	74·66
54·72	97·05
65·45	125·42
79·72	169·27
97·66	236·45

The action of salts on the animal organism is very diversified, and in most instances remarkable, and in many instances either mightily medicinal or powerfully poisonous. "Iodide of potassium, sulpho-cyanuret of potassium, ferrocyanuret of potassium, chlorate of potash, silicate of potash, and all salts with alkaline bases, when administered internally to man and animals in dilute solutions, or applied externally, may be again detected in the blood, sweat, chyle, gall, and splenic veins; but all of them are finally excreted from the body through the urinary passages. Each of these substances, in its transit, produces a peculiar disturbance in the organism—in other words, they exercise a medicinal action upon it, but they themselves suffer no decomposition. If any of these substances enter into combination with any part of the body, the union cannot be of a permanent kind; for their re-appearance in the urine shows that any compounds thus formed must have been again decomposed by the vital processes. Neutral citrates, acetates, and tartrates of the alkalies, suffer change in their passage through the organism. Their bases can indeed be detected in the urine, but the acids have entirely disappeared, and are replaced by carbonic acid which has united with the bases. The conversion of these salts of organic acids into carbonates, indicates that a considerable quantity of oxygen must have united with their elements; and there is no evidence presented by the organism itself, to which they have been administered, that any of its proper constituents have yielded so great a quantity of oxygen as is necessary for their conversion into carbonates; so that their oxidation can be ascribed only to the oxygen of the air. During the passage of these salts through the lungs, their acids take part in the peculiar process of eremacausis proceeding in that organ. A certain quantity of the oxygen gas inspired unites with their constituents, and converts their hydrogen into water, and their carbon into carbonic acid. Part of this latter product (1 or 2 equivalents) remains in combination with the alkaline base, forming a salt which suffers no further change by the process of oxidation; and it is this salt which is separated by the kidneys or liver. It is manifest that the presence of these organic salts in the blood must produce a change in the process of respiration. A part of the oxygen inspired, which usually combines with the constituents of the blood, must, when they are present, combine with their acids, and thus be prevented from performing its usual office. The immediate consequence of this must be the formation of arterial blood in less quantity, or in other words, the process of respiration must be retarded. Neutral acetates, tartrates, and citrates placed in contact with the air, and at the same time with animal or vegetable bodies in a state of eremacausis, produce exactly the same effects as we have described them to produce in the lungs. They participate in the process of decay, and are converted into carbonates just as in the living body. If impure solutions of these salts in water are left exposed to the air for any length of time, their acids are gradually decomposed, and at length entirely disappear. Free mineral acids, or organic acids without volatility, and salts of mineral acids with alkaline bases, completely arrest decay when added to decaying matter in sufficient quantity; and when their quantity is small, the process of decay is protracted and retarded. They produce in living bodies the same phenomena as the neutral organic salts, but their action depends upon a different cause. The absorption by the blood of a quantity of an inorganic salt sufficient to arrest the process of eremacausis in the lungs, is prevented by a very remarkable property of all animal membranes, skin, cellular tissue, muscular fibre, &c.,—namely, by their incapability of being permeated by concentrated saline solutions. It

is only when these solutions are diluted to a certain degree with water that they are absorbed by animal tissues. A dry bladder remains more or less dry in saturated solutions of common salt, nitre, ferro-cyanuret of potassium, sulpho-cyanuret of potassium, sulphate of magnesia, chloride of potassium, and sulphate of soda. These solutions run off its surface in the same manner as water runs from a plate of glass besmeared with tallow. Fresh flesh, over which salt has been strewed, is found, after 24 hours, swimming in brine, although not a drop of water has been added. The water has been yielded by the muscular fibre itself, and having dissolved the salt in immediate contact with it, and thereby lost the power of penetrating animal substances, it has on this account separated from the flesh. The water still retained by the flesh contains a proportionally small quantity of salt having that degree of dilution at which a saline fluid is capable of penetrating animal substances. This property of animal tissues is taken advantage of in domestic economy for the purpose of removing so much water from meat that a sufficient quantity is not left to enable it to enter into putrefaction. In respect of this physical property of animal tissues, alcohol resembles the inorganic salts. It is incapable of moistening, that is, of penetrating, animal tissues, and possesses such an affinity for water as to extract it from moist substances.

"When a solution of a salt, in a certain degree of dilution, is introduced into the stomach, it is absorbed; but a concentrated saline solution, in place of being itself absorbed, extracts water from the organ, and a violent thirst ensues. Some interchange of water and salt takes place in the stomach; the coats of this viscus yield water to the solution, a part of which, having previously become sufficiently diluted, is, on the other hand, absorbed. But the greater part of the concentrated solution of salt remains unabsorbed, and is not removed by the urinary passages; it consequently enters the intestines and intestinal canal, where it causes a dilution of the solid substances deposited there, and thus acts as a purgative. Each of the salts just mentioned possesses this purgative action, which depends on a physical property shared by all of them; but, besides this, they exercise a medicinal action, because every part of the organism with which they come in contact absorbs a certain quantity of them. The composition of the salts has nothing to do with their purgative action; it is quite a matter of indifference as far as the mere production of this action is concerned (not as to its intensity), whether the base be potash or soda, or in many cases lime and magnesia, and whether the acid be phosphoric, sulphuric, nitric, or hydrochloric. If we drink, fasting, a glass of common spring water every ten minutes, a strong diuretic action becomes apparent, the quantity of salts in the water being much less than that in the blood. When the second glass is taken, a quantity of urine is eliminated, the weight and volume of which corresponds nearly to that of the first glass; and by drinking twenty successive glasses of water, nineteen evacuations of urine take place, the last of which is colourless, and scarcely differs in its amount of saline ingredients from the spring water itself. When the same experiment is made with a water containing exactly the amount of salts as in blood ($\frac{3}{4}$ to 1 per cent. of common salt for example), a separation of urine is not effected, and it becomes almost impossible to drink more than three glasses of such water. A sensation of fulness in the stomach, of pressure and weight, seem to show that water containing an equal amount of saline ingredients as blood, requires a much longer time to be taken up by the blood-vessels. When the water taken contains a larger amount of salts than that existing in blood, a more or less active purgative action ensues. Hence, we see that three kinds of action take place, according to the quantities of salt existing in the water.

"Besides these salts, the action of which does not depend upon their power of entering into combination with the component parts of the organism, there is a large class of others which, when introduced into the living body, effect changes of a very different kind, and produce diseases or death, according to the nature of these changes, without effecting a visible lesion of any organs. These are the true inorganic poisons, the action of which depends upon their power of forming permanent compounds with the substance of the membranes and muscular fibre. Salts of lead, iron, bismuth, copper, and mercury belong to this class. When solutions of these salts are treated with a sufficient quantity of albumen, milk, muscular fibre, and animal membranes, they enter into combination with those substances, and lose their own solubility; while the water in which they were dissolved loses all the salt which it contained. The salts of alkaline bases extract water from animal substances; whilst the salts of the heavy metallic oxides are, on the contrary, extracted from the water, for they enter into combination with the animal matters. Now, when these substances are administered to an animal, they lose their solubility by entering into combination with the membranes, cellular tissue, and muscular fibre; but in very few cases can they reach the blood. According to all the experiments yet made on the subject, it appears, that after the lapse of the same time as is required for the appearance of alkaline salts in the urine, the metallic salts above mentioned cannot be detected in that fluid. In fact, during their passage through the organism, they come into contact with many substances by which they are retained. By degrees, however, the constituents of the tissues with which they have combined are altered by

the change of matter; their nitrogen appears in the urine, and along with it the mineral elements previously combined with the organic matter, such as mercury, copper, &c. When such substances enter into combination with organised parts, the functions of those parts must be disturbed, and must take an abnormal direction, producing morbid phenomena. The action of corrosive sublimate and arsenious acid is very remarkable in this respect. It is known that these substances possess, in an eminent degree, the property of entering into combination with all parts of animal and vegetable bodies, rendering them at the same time insusceptible of decay or putrefaction; it is further known that the parts of a body which come in contact with these substances during poisoning, and which therefore enter into combination with them, do not afterwards putrefy; so that there can be no doubt regarding the cause of their poisonous qualities. It is obvious that if they are not prevented by the vital principle from entering into combination with the component parts of the body, and consequently from rendering them incapable of decay and putrefaction, they must deprive the organs of the principal property which appertains to their vital condition, viz., that of suffering and effecting transformations; or, in other words, organic life must be destroyed. If the poisoning is merely superficial, and the quantity of the poison so small that only individual parts of the body capable of being regenerated have entered into combination with it, then eschars are produced—a phenomenon of a secondary kind—the compounds of the dead tissues with the poison being thrown off by the healthy parts." [Liebig's Chemistry of Agriculture and Physiology.]

Many salts are constituents of soils and of manures, and play an essential and highly important part in the nutrition of plants. Some are the sole ingredients in special manures; some are invariable and mighty ingredients in organic manures; not a few occur or are formed in all fertile soils; and many, either in themselves, or in their bases, or acids, or elements, or recombinations, contribute the whole or very nearly the whole of the inorganic principles or incombustible parts both of wild plants and of cultivated crops. Some, such as the carbonate of ammonia, the carbonate of lime, the sulphate of lime, the nitrate of soda, the nitrate of potash, the phosphate of lime, and the phosphate of magnesia, perform offices within the soil and in vegetation which constitute the main difference between barrenness and activity; and some, such as several of those just named and also the silicate of potash, the carbonate of potash, the carbonate of soda, the carbonate of magnesia, the oxalate of potash, the oxalate of lime, the malate of potash, the malate of lime, and many more are essential constituents of many of the most valuable or best known plants of either the garden, the field, or the wilderness. The carbonate of lime, for example, occurs in pease, vetches, wheat, barley, timber trees, and many other plants; the carbonate of magnesia is often associated in plants with the carbonate of lime; the sulphate of lime occurs in small quantities in clover, lucern, sainfoin, turnips, and potatoes; the nitrate of soda occurs in barley; the nitrate of potash, in woad, horse-radish, sunflower, and common nettle; the phosphates, in the seeds of the cereal grasses and of the sarcolobous legumes; the silicate of potash, in the culms of grasses; the carbonate of potash, in potatoes and in many shrubs and timber trees; the carbonate of soda, in fuci, salsolas, and most land-plants which grow near the sea; the oxalate of potash, in sorrel and some fuci; the oxalate of lime, in rhubarb, parsley, spinach, squills, fennel, and tormentil; the malate of potash, in rue, madder, nasturtium, lilac, and garden purslane; and the malate of lime, in wake-robin, houseleek, and mignionette. Some salts, also, occur in the roots, some in the stem, some in the leaves, and some in the seeds of the same plant; and several or even many sometimes occur, in a common association, either throughout an entire plant or throughout some of its parts. For example, no fewer than fifteen salts, besides some binary salt-like bodies, have been found in two of the most common fuci of the British shores,—the sulphate of potash, the oxalate of potash, the silicate of potash, the hydriodate of potash, the malate of potash, the muriate of potash, the carbonate of potash, the sulphate of soda, the carbonate of soda, the muriate of soda, the sulphate of magnesia, the muriate of magnesia, the phosphate of magnesia, the oxalate of lime, and the phosphate of lime. The multiplicity and importance of the range of saline action in the way of supplying direct nutriment to vegetables may be sufficiently inferred from our articles MANURE and FOOD OF PLANTS; the width and power and diversity of that action, in the way of preparatory or digestive transmutation of substances for the service of vegetation, may be partly conjectured from our articles MANURE, ALKALIES, LIME, AMMONIA, and NITRATES; and the particular action or actions of some of the most important salts, or of their constituent principles, either directly or indirectly or by recombination, may be learned from our articles MANURE, ALKALIES, ALUMINA, ACIDS, SODA, POTASH, LIME, CHALK, GYPSUM, AMMONIA, MAGNESIA, CARBONATES, NITRATES, PHOSPHATES, SILICA, and ASHES.

Many salts perform the whole of their fertilizing action, and others perform a main or considerable part of it, by undergoing decomposition, and letting loose their bases and their acids, to work out results independently of each other, and according to their respective nature; and in not a few instances, they set up a reciprocating process between decompositions and recombinations within the soil and decompositions

and recombinations within the vegetable organisms, which goes round a large circle or lengthens out to a prolonged series of feeding and vegetating effects. A large quantity of the alkalies and the alkaline earths is united in plants with a great variety of acids which are formed by the vegetable organisms, and which can be found nowhere but in vegetable juices and secretions; and all these alkalies, except perhaps in the few cases in which the vegetable salts may be supposed to spring direct from green manures or from the remains of dead plants or of dead parts of plants, must be derived from such a decomposition of mineral salts within the soil as drives the bases and the acids asunder, and allows the former to pass into the plants and the latter to remain entirely in the ground. The liberated alkalies and alkaline earths of the strongest or most characteristic mineral salts, such as the sulphates, the muriates, the nitrates, and the carbonates, in many instances, form new salts, of slender affinities or of plant-feeding elements, such particularly as the humates, before entering the plants,—and so carry up to the organisms, not only their own substance for combination with the vegetable acids, but also some elements to be pushed asunder from that substance, and appropriated to other departments of nutrition; and the acids of the decomposed mineral salts, when let loose on the soil, act on its most refractory constituents, such as its silica and its alumina, and form new mineral salts which, in their turn, play a similar part to that of the original salts. All the bases are thus digesting and carrying up the principles of the organic remains within the soil; all the mineral acids are attacking and reducing the constituents of gravel and slate and sandstone and metamorphic rocks and basalts within the soil; new supplies of bases are thus obtained, new absorbable preparations of organic remains are made, new evolutions of reducing acids are effected; and a continual circle of fertilizing process is thus going round. The action of mineral salts, in the way of manure, hence appears at once clear, mighty, and manifold; and can readily be understood to arise from very small doses; and, in all cases in which the requisite amount of basal and of organic matter exists in the soil, may easily be seen to be both certain and permanent.

Salts viewed as agents in vegetation, however, owe all their peculiarity of action to their acids; and, in order that they may be duly understood, they must be distributed into two classes, the one with organic acids, and the other with inorganic acids. "Perhaps no principle in agriculture," says Dr. Dana, "is better established than that an excess of any salt, in the usual acceptation of that term, is a cause of barrenness. Yet it is quite as well established, that the quantity of different salts admits of some latitude, and that some salts do produce better results than others. Referring to the acid constituents of these salts, it will be found that some acids are organic; they consist of hydrogen, carbon, oxygen, all which under the influence of the living plant, may be dissociated, and their elements form geine. Other acids consist of oxygen and nitrogen, essential constituents of plants; others consist of chlorine; others of sulphur and oxygen, and others of carbon and oxygen. In other words, the acids are composed of elements, which form food for plants, or of elements which enter in a small proportion only into the composition of plants. In the first case, the salts admit of a larger quantity being applied, than in the second. By the first, plants are fed,—by the second, they are poisoned; for the base of all salts acting, as has been explained, the acid is eliminated. If this is set free in large quantities, and its elements can be taken up and converted by the plant, well, good effects follow; if on the other hand, the elements of the acid are such as the plant demands not, its presence acts on the plant like poison on the animal economy. Let salts be divided into two classes, on this principle of the peculiarity of action depending upon the acid of the salts,—the first nourishes, the second poisons plants. The first class contains, first, carbonates—second, nitrates—third, phosphates.

"The action of the first class is to be studied under its three divisions. First, the carbonates. These include a very large portion of all salts used in agriculture,—such as limestone, marble, old mortar, shells, and shell marl. In all these cases, the base or lime, let loose by the action of the living plant, acts at once as caustic lime upon insoluble geine and unconverted vegetable fibre, changing these into soluble vegetable food; while the carbonic acid acts immediately upon silicates, decomposing these, and upon the geates in the soil, converting these into super-geates. Carbonates of alkalies, as ashes, &c., act at once; they are soluble, their alkali acts immediately upon the geine; their carbonic acid acts upon silicates and geine. Immediate and decided good effects follow their application; while carbonate of lime acts slower. All fat acids or fats and oils, also act upon silicates, partly by their own acid properties and partly by the evolution of carbonate acid gas, which is evolved during their conversion into the acid state. The quantity of carbonate of lime which may be applied is unlimited, and the quantity of alkali depends on the presence of insoluble geine. The more abundant is the last, the more freely may alkalies be applied. The carbonates include ashes of all kinds, and agriculturally viewed, all kinds of lime, for the quick soon becomes mild. The value of ashes in agriculture, depends upon their being a combination of salts, derived from plants, all of which have a powerful and decidedly beneficial effect. Peat ashes abound in carbonate, sulphate, and especially phosphate of lime. Free alkali may be always traced in peat ashes; but

alkali exists in it, rather as silicate, as in leached ashes. Anthracite coal ashes contain carbonate of lime, alumina, and oxide of iron; and it is good, so far as these abound.

"The nitrates, or second class of nourishing salts, include not only saltpetre, both East Indian and South American, or nitrate of potash and nitrate of soda, but also all composts of lime, alkali, and animal matter. These produce ammonia, which, without the lime would act on geine, and render that soluble. Ammonia, by the mere act of presence, hastens decay; but without the influence of lime, ammonia is changed to a nitrate of that base, or to nitrate of ammonia. Thus in a compost of animal matter without alkaline bases, not only has not all the geine been rendered as soluble, as is usually supposed, by the action of ammonia, but the absence of alkali has caused the ammonia, before its full action has occurred on the organic matter, to be converted into a nitrate of that base. But if the lime exceeds that which the nitric acid can saturate, then the soluble geine is seized upon, and becomes inert. Nitrates act under the influence of the growing plant, the base let loose acts on geine, the acid is decomposed, and nitrogen given up to the plant, and it becomes one of their essential elements. The elements of nitrate of ammonia are all taken up, both acid and base. If there are any salts which can be called vegetable food, they are the nitrates. The immediate effects of saltpetre or of any other alkaline nitrate are due to the liberated alkali, acting on the geine; and its permament effects, for experience has proved permanency of effect peculiarly due to nitrates, are owing to the liberation of an immense dose of oxygen, which is produced from the gradual decomposition of the acid. Now the insoluble geine condenses this in its pores, like charcoal. This condensation, like that of gas by charcoal, produces heat; it is like fermenting manure, while the condensed oxygen acts slowly on the geine, forming carbonic acid. It has upon the geine, buried in the soil, the same effect that tillage would have, rendering it soluble, with this additional advantage,—that its carbonic acid instead of escaping acts on the silicates. New portions of alkali are thus liberated, supplying for years that which was first applied, as a part of the saltpetre. The nitrates then, hold the very first place among salts, in agriculture.

"The phosphates—or third class of nourishing salts—include bones, horn, hair, nails, hoofs, and claws, and a large portion of the salts found in the liquid excretions of animals. These act much like nitre, the acid forming a constituent of the plants. It is not probable that the acid in this class is decomposed. It has not yet been proved that carbonates and nitrates exist already formed except in a very few plants. The quantity of salts which may be applied, will be greatest in the carbonates, next in the nitrates, and thirdly in the phosphates. The quantity of any salt which may be used will, after the largest amount, which can be safely employed has been ascertained, depend upon the farmer's ability to produce it. Carbonate of lime may be used to any extent, according to the farmer's idea of its value. Carbonates of alkali may be used with benefit. The largest quantity which has been known to be used without injury, has been 53 bushels of ashes per acre, which are equal to 240 lbs. of potash. The quantities used must be determined by experiment, and perhaps when the largest amount, which has been stated, is taken for a new starting point, the ultimate quantity will be found limited only by the geine in the soil, or applied in conjunction with the salt.

"If we now turn to the other division of salts, the poisons, that is those whose acid forms but a small portion of the elements of plants, we find two classes,—first, sulphates, as gypsum, copperas, Glauber's salt, all of which in small quantities are beneficial. An explanation, which attributes the action of sulphate of lime or plaster, to its power of decomposing and fixing in soil carbonate of ammonia ought to show, first, the actual presence of that salt in air,—second, that sulphate of ammonia is not decomposed by the resulting carbonate of lime in the cold,—and third, that common salt would, in equivalent quantity with plaster, produce equally good effects. It never has, and therefore this explanation is not correct.—Secondly, muriates or chlorides, as they are strictly called, as common salt, muriate of lime, bittern, spent ley from soap-works. Common salt has been found beneficial when applied at the rate of 30 bushels per acre; and at 14 bushels per acre, was found to produce effect next best to 53 bushels of ashes per acre; but quick lime at 26 bushels per acre on the same land, produced no good result.

"In all this action of salts, it is seen that the presence of life seems almost essential. Whatever the vital principle be, it may be best represented as analogous to electricity and galvanism. In this point of view, the salts present themselves in a new relation,—in a relation, in which alone, they may be said to be stimulants or excitants. Plants and soil act, it may be supposed, for illustration, by forming galvanic batteries or piles with each other. The most active element in the pile is the growing plant. It is an acknowledged fact, that chemical action, if not the source is ever attended by electrical effects. An acid, in contact with an alkali, or metal, always produces chemical action; but the silicates of the soil are already combinations of acid and metals; hence as such, they have no tendency to act on each other. If there be added to these a salt or an acid, chemical action, decomposition begins. The electricity is, we may say, excited by salts—they are in this sense, and in no other, excitants or stimulants. The very first act of vegetation, the germination of seeds,

induces this electric action, this decomposition of the elements of soil. Germination produces carbonic acid, by decomposing water. The very first act of life in a seed is to evolve carbonic acid, by its carbon combining with oxygen of air, and its second act is to decompose water. Its oxygen combines with the carbon of the seed; a single bean produces many times its bulk of carbonic acid gas; and in the soil would surround itself with an atmosphere of carbonic acid. This evolved, begins its action upon the silicates. The living seed begins the electric action, and the plants exert and keep up this influence. Salts act in a similar way; but above all, over all, influencing all, is the living plant. This electric action induced, extends to undetermined distances; hence there is a transfer, as is usual in all cases of galvanic decomposition, of substances remote from the plant, to its root, where they are taken up. It is not the potash and lime, &c., immediately in contact with the root, which alone supplies the plant; but under the galvanic influence, an undetermined portion of soil is decomposed. This decomposing agency of plants wholly destroys all confidence in experiments, undertaken to prove that pure water alone can nourish plants. The containing vessel, that is the vessel in which the experiment is made, is itself always decomposed. If to guard against an error glass is used, it has already been shown that this is only a combination of silicates, and these will be transferred from the glass to the plant."

SALT (Common),—chemically *Chloride of Sodium.* A compound of one equivalent of chlorine and two equivalents of sodium. It may be directly formed by burning sodium in chlorine, or by heating it in hydrochloric acid gas; and it is deposited in crystals from a solution of muriate of soda. But it naturally occurs in vast quantities as a mineral deposit of the saliferous sandstone formation,—in immense quantities as a saline impregnation of sea-water and of the water of salt springs,—and in small quantities as a sapid ingredient of most of the waters which flow from any part of the land into the sea. It may be regarded as a true mineral; for it is always the solid or ultimate form into which the muriate of soda of the sea and of salt springs is resolved by evaporation; and it passes from the interior of all countries toward the final receptacle of rivers; and it generally accumulates more, and forms a stronger brine, in inland seas which have no outlet, and particularly in such a narrow evaporating basin as the Dead Sea, than in the open and far-expanding ocean. Its crystals, from slow evaporation, are cubic,—and from rapid evaporation, are hollow, four-sided prisms; and they contain no water of crystallization, but enclose particles of water among their interstices, and decrepitate powerfully when heated. Its taste is agreeably saline. It slightly deliquesces in a moist atmosphere, but undergoes no change in a dry one. It fuses at a red heat, and cools down into a brittle transparent mass. It dissolves in about $2\frac{1}{2}$ times its weight of water, of any temperature from 60° to 212°; and it passes into muriate of soda in the act of dissolving. Solid common salt is thus akin in constitution to an oxide, and consists of two simple or elementary ingredients,—a metal and a salt radical; and dissolved common salt is strictly a true salt, and consists of two compound or binary ingredients,—an oxide and an acid.

The Varieties of Salt.—The ordinary common salt of the useful arts, in all its varieties of fishery salt, bay salt, and stored salt, is obtained by evaporation of sea-water; and is very seldom pure, or even nearly pure; and often contains a considerable intermixture of the other salts which are associated with muriate of soda in the sea. See the article Sea-Water. The sulphate of magnesia, the muriate of magnesia, and the sulphate of lime which occur in it may be precipitated as carbonates, by boiling a solution of it during a few minutes with a slight excess of carbonate of soda, and then filtering the liquid, and neutralizing it with muriatic acid. The differences which exist among the many varieties, arise solely from diversities in the mode of preparation; and the chief groups of the varieties are common British salt, foreign bay salt, and Dutch salt. A specimen of common Scotch salt analysed by Dr. Henry contained 0·4 per cent. of insoluble matter, 2·8 of muriate of magnesia, 1·5 of sulphate of lime, 1·75 of sulphate of magnesia, and 93·55 of chloride of sodium; a specimen of Sunday Scotch salt contained 0·1 per cent. of insoluble matter, 1·15 of muriate of magnesia, 1·2 of sulphate of lime, 0·45 of sulphate of magnesia, and 97·1 of chloride of sodium; a specimen of common Lymington salt contained 0·2 per cent. of insoluble matter, 1·1 of muriate of magnesia, 1·5 of sulphate of lime, 3·5 of sulphate of magnesia, and 93·7 of chloride of sodium; a specimen of cat Lymington salt contained 0·1 per cent. of insoluble matter, a large trace of muriate of lime, 0·5 of muriate of magnesia, 0·1 of sulphate of lime, 0·5 of sulphate of magnesia, and 98·8 of chloride of sodium; a specimen of St. Ube's bay salt contained 0·9 per cent. of insoluble matter, a trace of muriate of lime, 0·3 of muriate of magnesia, 2·35 of sulphate of lime, 0·45 of sulphate of magnesia, and 96·0 of chloride of sodium; a specimen of St. Martin's bay salt contained 1·2 per cent. of insoluble matter, a trace of muriate of lime, 0·35 of muriate of magnesia, 1·9 of sulphate of lime, 0·6 of sulphate of magnesia, and 95·95 of chloride of sodium; a specimen of Oleron bay salt contained 1·0 per cent. of insoluble matter, a trace of muriate of line, 0·2 of muriate of magnesia, 1·95 of sulphate of lime, 0·45 of sulphate of magnesia, and 96·425 of chloride of sodium; a specimen of Dutch salt, in large and very small crystals, analysed by Professor Traill, contained 0·065 per cent. of insolu-

ble matter, 0·044 of muriate of lime, 0·506 of muriate of magnesia, 0·7 of sulphate of lime, 0·398 of sulphate of magnesia, and 98·287 of chloride of sodium; a specimen of Dutch salt, in smaller grain than the preceding, but still remarkable for the regularity of its crystals, contained 0·09 per cent. of insoluble matter, 0·099 of muriate of lime, 0·201 of muriate of magnesia, 0·4 of sulphate of lime, 0·2985 of sulphate of magnesia, and 98·9115 of chloride of sodium; and a specimen of Dutch salt, in less regular and much smaller crystals than the preceding, but still more symmetrical in crystal than British salt of the same size of grain, contained 0·07 per cent. of insoluble matter, 0·0935 of muriate of lime, 0·1765 of muriate of magnesia, 0·57 of sulphate of lime, 0·4415 of sulphate of magnesia, and 98·6485 of chloride of sodium. The analysis of specimens of four different kinds of Cheshire rock-salt may be advantageously compared with these analyses of sea-salts, for the purpose of guiding purchasers who use large quantities of salt as a condiment for cattle, and especially as an antiseptic. A specimen of crushed rock-salt, analysed by Dr. Henry, contained 0·1 per cent. of insoluble matter, 0·0063 of muriate of lime, 0·0187 of muriate of magnesia, 0·65 of sulphate of lime, and 98·325 of chloride of sodium; a specimen of fishery rock-salt contained 0·1 per cent. of insoluble matter, 0·025 of muriate of lime, 0·075 of muriate of magnesia, 1·125 of sulphate of lime, and 98·675 of chloride of sodium; a specimen of common rock-salt contained 0·1 per cent. of insoluble matter, 0·025 of muriate of lime, 0·075 of muriate of magnesia, 1·45 of sulphate of lime, and 98·35 of chloride of sodium; and a specimen of store rock salt contained 0·1 per cent. of insoluble matter, 0·025 of muriate of lime, 0·075 of muriate of magnesia, 1·55 of sulphate of lime, and 98·25 of chloride of sodium.

"On comparing these analyses," remarks Professor Traill, "we find that the Dutch salt is very superior in purity to bay salt, and still more so to most of the salt obtained in Britain from sea-water. The specimens even surpass in purity the salt prepared from Cheshire rock-salt. This is chiefly owing to their containing less sulphate of lime than the salt of Cheshire; while, however, they are contaminated with larger proportions of the earthy muriates and sulphate of magnesia, from all which the Cheshire salt is remarkably free. The contaminating saline ingredients which are most detrimental to salt, as a preservative for meat, are undoubtedly the earthy muriates or hydrochlorates, and next to these, the sulphate of magnesia, because they are either very soluble or deliquescent, and therefore cause rapid melting of the common salt, into which they largely enter, and thus its value in the preservation of fish and flesh is greatly impaired. When a salt of easy solubility is applied to preserve fish or flesh, it soon dissolves in the animal juices, and readily absorbs moisture from the air; in that case, the upper portions of the fish or flesh are speedily deprived of the salt, and thus become liable to pass to putrefaction. The remarkable purity of the Cheshire salt from deliquescent saline contaminations, would seem to point out its peculiar fitness for the fisheries, and the salting of animal flesh; yet I believe it is admitted, that Dutch salt is preferable for the first, which must depend on some of its other qualities. On examination, it would seem that its value for such purposes depends on its superior hardness, and the size of its grain. The large-grained and dense salt, when strewed between the layers of fish or flesh in a cask, every other thing being equal, will remain longest solid, and by its very gradual dissolving, continue to afford a succession of saline particles to the upper portions of the animal matter, as well as to the lower, and to keep it thoroughly impregnated with salt. A large-grained hard salt has been formed by a slow evaporation; and if the very pure salt of Cheshire were crystallized more slowly than it is, there can be no doubt that it would afford a fishery salt superior to every other now in use. For the first part of the process of salting meat, the formation of the brine for immersion of the animal matter, and what is called striking it with salt, the small-grained pure salts are perfectly applicable; and for this purpose, I do not think that the third kind, or even the second kind, of the Dutch salt, mentioned in the analysis, has any superiority over the Cheshire salt; but the large and hard grain of the first kind of the Dutch salt more than compensates for any little inferior degree of purity, when employed for strewing between layers of fish or flesh in the casks. For the due preservation of butter, no kind of salt seems preferable to the larger grained varieties of Cheshire salt. The sulphate of lime, as it exists in this salt, is of small consequence; while its extreme purity from the contamination of earthy hydrochlorates and of the bitter sulphate of magnesia, render it but little likely to impart any disagreeable flavour to that delicate article of diet."

Rock salt occurs in the sides and bottoms of salt lakes in America, and in vast beds of the saliferous sandstone formation in England, in Continental Europe, and in most other parts of the world. The beds of it in Cheshire vary in thickness from 4 to 130 feet; and alternate with limestone, clay, swinestone, sandstone, and indurated, gypseous marls. It occurs both massive and dentiform, and also in straight and curved fibrous concretions, and is commonly yellowish, greyish, or very white, with flesh-coloured, red, and violet stripes, and is highly translucent or almost semitransparent, and breaks into splintery fragments, and presents externally a resinous lustre, and internally a shining and glistening appearance; and, when exposed to strong heat either on the coals or from the blow-pipe, it smartly decrepitates. A peculiar kind of it decrepitates

in water, and, in the process of dissolving, emits a gas of similar composition to carburetted hydrogen. The coloured varieties owe their colour to the presence of animalcules; and even the clear kind, as well as the red, contains a monad, which may readily be seen by placing a few particles of the salt with a little water on the object-glass of a microscope, and observing the residue after the salt is melted.

The Uses of Salt in the Arts.—Salt is the most commonly used of all antiseptics for the preserving of meat. See the section "Salting of Meat" in the article MEAT. It is also employed in large quantity for the manufacture of bleaching-powder, hydrochloric acid, and the best carbonate of soda. "In preparing hydrochloric acid from salt, which is done by the aid of the oil of vitriol, sulphate of soda is formed, from which, by heating it with charcoal, carbonate of soda is obtained. Thus, in the very important manufacture of soda from salt, both the chlorine and the sodium are made use of, the hydrochloric acid being but a secondary product, formed in the first stage of the manufacture of carbonate of soda, a product nearly equal in importance to the oil of vitriol, by means of which it is made."

The Uses of Salt to Animals.—Salt, in small quantities, and in accompaniment with food, is highly relished by man and by almost all quadrupeds, whether domesticated or wild; and acts at once as a condiment, for giving agreeable sapidity to food,—as a tonic, for assisting the process of digestion,—as an aliment, for contributing certain principles to the blood and some of the liquid secretions,—and as a medicine, both to prevent some diseases in a healthy system, and to aid or effect the cure of others in a morbid one. It renders many articles of food grateful, both raw and prepared ones, which would otherwise be nauseous; it produces a heat, a stimulation, and a gentle causticity in the stomach and the small intestines, which always assist digestion, and are often essential to it; it contributes the free hydrochloric acid of the gastric juice, the soda of the bile and the blood, and the soda salts of some other animal fluids; and it prevents worms in man and rot in sheep, and putrefactive tendencies in all animals who use it, and operates as an useful aperient and a mild restorative under various forms of both acute and chronic disease. The efficacy of it against parasitical worms in man will sufficiently illustrate its general value. "A lady is spoken of in the London Medical Journal who had a natural antipathy to salt, and was consequently most dreadfully infested with worms during the whole of her life. In Ireland, where, from the bad quality of the food, the lower classes are greatly infested with them, a draught of salt and water is a popular and efficacious cure. Dr. Paris has noticed the bad effects of a diet of unsalted fish. Rush says that he has administered many pounds of common salt with great success in worm cases. Lord Somerville, in his address to the Board of Agriculture, gave an interesting account of the effects of a punishment which formerly existed in Holland. 'The ancient laws of that country ordained criminals to be kept on bread alone, unmixed with salt, as the severest punishment that could be inflicted upon them in their moist climate. The effect was horrible; these wretched criminals are said to have been devoured by worms engendered in their own stomachs.' The wholesomeness and digestibility of our bread are undoubtedly much promoted by the addition of salt which it so universally receives. Dr. Dyer says, that in the Mauritius, the planters' slaves rarely obtain salt, and are therefore extremely subject to worms, while the government slaves and the convicts get salt in their rations, and seldom suffer from those intestinal parasites. Some planters, regarding economy and the health of their slaves at the same time, give a table-spoonful of salt in half a pint of water to each slave regularly every Saturday after work; and they find that this dose acts not only as a vermifuge, but as a tonic."

The uses of salt, whether condimentally or medicinally, for all kinds of live stock, are quite as extensive and varied as the uses of it for man, and in many respects are the same, but in others are different. It gives sapidity and relish to grasses, hay, and other kinds of raw food; it acts universally as a stimulus to digestion; it renders coarse food more nourishing, and moist food less injurious; it restores the tone of the stomach when impaired by excess of either food or labour, and often recals the appetite more speedily than any other tonic; it preserves health, and improves the general condition; it is a purgative second only to Epsom salt when given in the first instance, and acts with high certainty when preceded by a dose of Epsom salt which fails to purge, but, in consequence of its being a tonic as well as an aperient, it is unsuitable in an early stage of any fever; it acts with great power and general efficiency as a vermifuge; it serves, in external application, as an excellent discutient, a hardener of sore places, and an abater of inflammation; it improves the quality of excrement for the purposes of manure; and it so greatly tames the disposition, and overcomes natural timidity, that sheep gather round a shepherd to receive distributions of it, and the wildest cattle come to lick it out of the hand. In all its internal uses, however, whether as a condiment or as a medicine, it requires to be administered in small and measured quantity; for whenever it is given too freely, it not only does no good, but may produce very serious evil.

Salt is of great use to horses. It makes them relish their food, and incites them to work well, and assists their general health and condition, and is a preventive or a cure of bots and grease. A quantity of about four ounces in the day, sprinkled in several doses of about a table-spoonful each

on their steamed potatoes or on their other crib food, is peculiarly appropriate. A poor torn-down horse, if put into a salt-marsh, may, by means of the salt which he there receives with his food, be purged and cleared of every disorder, and speedily become fat. The horses of many parts of America are daily fed each on from 4 to 5 gallons of oats, besides hay, and receive each a good handful of salt about twice a-week; and they are excellent workers, and continue in high condition, even when performing long journeys at the rate of 45 miles a-day. Some horses in whose manger a lump of rock salt has been regularly laid every spring and autumn, have eagerly licked it, and have, with little exception, continued in good health during 14 years. Horses about to be called out to extraordinary exertion have received a little salt by way of preparation for their work, and seem to have been sustained by it under their extreme fatigue in a similar way to the camels who receive a little salt during the passage of the caravans across the deserts of the East.

Salt has the same effects on the ass and on the mule as on the horse. Wild asses feed chiefly on the most saline and bitter plants of the desert, such as the salsolas, the atriplices, and the chenopodiums; and they seem to recognise and relish saline vapours at a comparatively great distance from the sea or from lakes, and in consequence readily discover distant waters by the smell. The mules who work in the Real del Monte silver mines in Mexico have such a greed for salt that they constantly lick the ore, which consists of mercury and sulphuret of silver in amassment with salt and with iron pyrites; and, though they in consequence take in large impregnations of the metals, they suffer no inconvenience; and, on opening them after death, considerable quantities of silver are sometimes found amassed in their stomach.

Salt has been known from ancient times and in mutually far-distant countries to be highly beneficial to cattle. Pliny, in his Natural History, tells us that cattle have an avidity for salt pasture, and that cows who graze on it give milk in larger quantity and of better cheese-making quality than cows fed on insaline lands. Dickson, in his Husbandry of the Ancients, says that the Romans prepared the straw for cattle-food by steeping it for a considerable time in brine, and then drying it, and rolling it up in bundles. An American writer in the Museum Rusticum, about 85 years ago, said, "We think salt in a manner absolutely necessary, and accordingly give it to every kind of cattle; and to this practice of feeding with salt, it is generally ascribed that our cattle are so much more healthy than the same animals in England; certain it is that they are subject to much fewer diseases." In some parts of Africa, large herds of cattle travel from great distances, at stated seasons, to enjoy the marine plants which grow on the coast and are saturated with sea-salt. The fattening property of our own salt marshes is well known to graziers and farmers. In Smith's Wonders, it is stated that the water of the salt mines near Eperies, in Upper Hungary, affords a blackish salt, which is generally given to cattle. For many years, it has been the custom in Germany, and particularly in Wirtemberg, where a vast number of oxen are bred, to give doses of glauber salt to cattle. As long as common salt was more expensive than glauber salt, it was thought that the inhabitants of Wirtemberg used the latter through economy; but this supposition must have been erroneous, as they still continue to use glauber salt, although the discovery of salt springs has rendered the domestic salt exceedingly cheap. The reason they assign for this preference is, that it conduces, by its purgative qualities, to keep the cattle in good health, and that even when, from long habit, they become less liable to be acted on by it, it still promotes digestion, and brings the beasts into good condition more rapidly. Matthew Aphonin, a Russian naturalist, remarks that "oxen fatten very quickly upon the sea-coasts where the arrow-grass, *Triglochin maritimum*, their favourite food, abounds;" and if this be so, it is probably ascribable to the saline nature of the plant, and to the sea breezes containing particles of salt. In Upper Canada, the cattle have plenty of wild pasture to brouse on in the woods; but, once in a fortnight, they return, of their own accord, to the farms, to obtain a little salt; and when they have eaten it, mixed with their fodder, they repair again to the woods. D'Azara tells us that, in some parts of Paraguay, salt is not given to the herds of cattle; but they are supplied with the barrero, a saline or nitrous earth, which they and other animals seek with avidity, and without which they fail and die in the course of four months. From the 27° of south latitude to the Malovine Islands, they have no need of the barrero, because the water and pasture-grounds are sufficiently salt; but northward, beyond this latitude, it is necessary, and the plains which do not contain it, feed neither the ox, horse, ass, mule, goat, nor sheep. In India, salt is given to bullocks daily, to the amount of 2 or 3 ounces, in their feed of pulse, or of a mixture of grain, vetches, and chaff; and so efficacious is it with this mixture of food as, in six or seven months, to render bullocks of 16 years of age, who have become superannuated from active service, as fit for the shambles, or as fine in the quality of their beef as the majority of oxen seen in the annual shows of Smithfield. A small quantity of salt in accompaniment with clover, turnip-tops, and other green and succulent food, tends to prevent hoove.

Salt is sometimes very serviceable to fattening calves. When a sucking calf does not get enough of milk, and requires to be fed with oatmeal-gruel, he may sicken and die if the gruel be salt-

less, but will thrive if it be salted; and when a calf who is fed solely on milk becomes disordered in stomach, and loathes his food, and does not increase in fatness, he will acquire a fine appetite, and begin rapidly to fatten, by means of the simple expedient of giving him small doses of salt dissolved in water. An able experimentalist, who gave evidence on the subject before a Committee of the House of Commons, currently allowed each of his calves one ounce of salt per day, and each of his milk-cows four ounces, and each of his feeding oxen from four to six ounces.

Salt is highly advantageous in many ways, to sheep. It averts the injurious effects of moist and humid situations where they may be required to graze. It greatly diminishes the loss or risk of depasturing them on such wet retentive lands as otherwise constitute unsound and sickening pastures. It prevents rot, braxy, scab, flatulent distension, intestinal worms, and other diseases which they are liable to contract from either unfavourableness of situation, changeableness of climate, or succulency of food. It promotes their general health, and modifies their natural timidity, and brings them very closely and submissively under the shepherd's care; and, whether artificially given, or merely aspersed on pastures by the sea-spray, it considerably improves the natural wool. In Spain, it is given to the amount of 128 lb. a-year to every 1,000 sheep; but in many parts of Britain, it might be given with advantage to the amount of so much as a ton to every 1,000 sheep; and in all very bad situations, it ought to be supplied in as large a quantity as they choose to consume. It should be given in the morning, in order that it may counteract the effects of the dew; and it may be supplied in ordinary cases twice a-week, and in extraordinary ones thrice. Ten or fifteen slates or small flat stones for holding it may be placed at distances of a few yards from one another for every 100 sheep; and a small handful may be laid on each. If the sheep have a craving for it, they will quickly lick it up; and if it do not seem to be quite to their present taste, it should immediately be gathered up again, and reserved for future use. See the articles Rot and Braxy.

Salt, in moderate quantity, promotes the health and accelerates the fattening of hogs. It should be mixed with their food at the rate of a large table-spoonful in 24 hours; and may be advantageously given in larger quantity, in cases where they eat it greedily and are observably affected by it as a purgative. When the use of it was introduced to the Irish piggeries, hogs were found to fatten in little more than half the time which was formerly common, and were found also to acquire a greater bulk of eventual fat. Salt is sometimes given to the hogs of America to render them tame, and to prevent them from irretrievably wandering or becoming wild in the forest.

All the quadrupeds of North America, both domesticated and wild, native and imported, have an instinctive passion for salt; and the ox, the bison, the deer, the elk, the bear, and other large animals, however strong may be their natural antipathies, and however distant their pasture-grounds, repair periodically to the saline and briny springs which are interspersed all over that great continent; and, in some instances, they have abraded the briny bottoms and luxuriated in the saline waters and licked the salt rock, till great excavations of 8 or 10 feet in depth have eventually been made, and most fantastic shapes of surface have eventually been fashioned. The argali or wild sheep who inhabits all the alpine regions of Central Asia, and occurs on the highest mountains of Greece, Corsica, and Barbary, is very fond of salt, and sometimes excavates the earth to a considerable depth to obtain it. The Scythian antelope, who frequents the open and dreary deserts around Mount Caucasus, near the Caspian Sea, and in Siberia, feeds largely on salt and on the plants which grow near salt springs. The chamois, who occurs chiefly on the Alps and the Pyrenees, and who feeds on the most delicate herbage it can find, is very fond of salt. Gazelles, who live in immense herds in the open plains, browze upon the saline and pungent herbage. And camels drink water which is too salt to be used by their human masters.

The Uses of Salt in the Cultivation of the Soil.—Salt, even in small quantities, operates fatally on cold-blooded animals, both of the land and of fresh water; and is therefore a convenient agent for easily clearing away worms, molluscs, newts, various insects, and other small animal nuisances. The warty newt, though generally very tenacious of life, dies with the most violent convulsions under a little sprinkling of salt; and snails, slugs, earthworms, and some common insects are speedily killed by an aspersion or syringing of brine or other strongly saline liquid. A sprinkling of salt on lawns, at the rate of ten bushels per acre, prevents worm-casts; a good watering of gravel-walks and other parts of gardens with a strong solution of salt kills worms and grubs and larvæ, and greatly aids to keep the walks and grounds in good order; the application of a strong solution of salt to various plants and beds with a garden syringe destroys some noxious insects; and the mixing of salt with seed-corn, or the aspersion of it as a top-dressing, is one of the surest agricultural appliances, for protecting the young corn-crops of the farm from some of their worst subterrane assailants. "In some parts of Scotland," says Sir John Sinclair, "where the oat-crops were frequently destroyed by grubs, &c., it has long been a practice to mix salt with the seed, in the proportion of 1 to 32, but sometimes 1 in 16. Every means has been taken to ascertain the utility of the practice, and with uniform success. Salt destroys vermin in the

ground, by making them void the contents of their bodies, such evacuations being too powerful for them to withstand. It has this additional advantage, that the vermin thus become food for those very plants which otherwise they would have destroyed."

Salt, used in various ways, is a well-known preventive or remedy of the fungal diseases of the cereal crops. The application of it as a manure or top-dressing tends more or less to prevent both rust and mildew; yet cannot always be depended on, and requires the exercise of some caution. Manuring with the refuse salt from the pilchard fishery in the South of England, was long ago found to be a constant preventive of rust in a district where the disease infested all the unsalted lands. The cautious aspersion of a clean solution of salt is one of the best known cures for actual mildew. See the articles Rust and Mildew. The immersion of seed-wheat in a brine of sufficient strength to float an egg, followed by the frequent stirring of the steep and the skimming away of all the light and unsound grains which rise to the top, has long been practised throughout a great part of England as a preventive of smut. See the article Smut.

The value of salt, in small quantities, as a manure, appears to have been well known in ancient times. Cato, Virgil, Pliny, and Columello all record its power of improving the herbage of pastures or the dried fodder of cattle; and two remarkable sayings in the Gospels — that the apostles of the Redeemer were "the salt of the earth," and that salt which has lost its savour "is neither fit for the land nor yet for the dunghill"—seem to point to a prevailing practical acquaintance, throughout the civilized world or at least in Palestine, with the fertilizing properties of salt. The use of it on sheep pastures or with sheep feed has been observed in Spain from the earliest times, and became known at an early period in Germany; the efficacy of it against "murrain or rotte," was known in England in the 16th century; and the direct fertilizing powers of it upon the soil were tested by experiment at Clapham about the middle of the 17th century. But salt became lost to British agriculture, in the reign of William III., by the imposition on it of a war-tax which raised the price of it from 6d. to upwards of 20s. per bushel: and it did not become available till the repeal of the tax in 1823. Many farmers were now totally ignorant of its adaptation to manurial purposes; and others made experiments with it in methods so loose, inaccurate, and preposterous as either to defeat its success or to bring it under serious suspicion. Most farmers, therefore, continued long indifferent about it; and some hotly disputed or angrily denied its claim to rank as a manure; and only a few, by means of enlightened experiment and patient recommendation, eventually brought it into general favour.

Salt operates in various ways as a fertilizer; but must always be applied in small quantity, and with due adaptation to one or more or all of its specific modes of action; for if used in excess or at improper times or in unsuitable circumstances, it may be useless or even hurtful. It is a direct though scanty principle of the food of some plants; it affords other principles of the food of plants, particularly soda, in result of a short and easy process of decomposition and recombination; it converts many hurtful organic bodies and refractory organic matters in the soil into principles of nutrition; it assists the complex, ameliorating chemical processes of fallowing, in their action on both the minerals and the artificial manures of the soil; it stimulates the organisms and accelerates the secretions of growing plants; it mitigates the evils of sourness and coldness and wetness in moist, stiff, grass lands; it promotes the tenderness and sapidity of gramineous herbage; it promotes the vegetation of oily seeds; it assists the action and increases the power of lime and soot and other artificial mineral manures; and it renders the soil to which it is applied more absorbescent of moisture from the atmosphere, and helps to protect both it and the crops growing on it from the injurious effects of great and sudden vicissitudes of temperature.

As to most of the methods in which salt acts directly as a fertilizer, however, it naturally exists in quite sufficient quantity in all localities near the sea, and requires to be artificially applied only in places which are little visited with saline vapours. "If we examine into the results of the experiments which have been made with salt as a manure," says Dr. Madden, "we shall find that, after leaving out those where obvious mistakes in quantity were made, they directly corroborate the opinion that the applicability of a special manure should be determined by analysis, in order to prevent the probability of a failure; for it will be found, by examination, that, in those cases where it either produced no effect, or was injurious, the soil was in a situation to receive supplies of salt from natural sources; whereas, the situations where salt is useful as a manure, are such as to exclude these natural supplies. It may not be generally known that the clouds which form over the sea always contain a greater or less quantity of salt, which of course will be deposited in the soil by the rain; and, moreover, that during the occurrence of sea-breezes, the spray travels to a very considerable distance inland, and is likewise deposited on the land. From these two sources it may be premised with comparative certainty, that places near the sea, particularly such as lie in the direction of the prevailing sea-breezes, will obtain a sufficiency of salt, whereas inland situations will, in all probability, be much benefitted by an artificial supply. To give some idea of the quantity of salt contained in clouds near the sea, I may

state that I last year analyzed the rain which fell at Penicuik, and found it to contain so large a proportion of salt, that, calculating the fall of rain at 31 inches per annum, each acre would receive 641 lbs. or nearly 6 cwt. of salt from this source alone. From detailed accounts of various experiments with salt, made in different situations, and published in the Transactions of the Highland Society, we find, that on the farm of Forest near Stonehaven, Kincardineshire, a spot freely exposed to the frequent east winds coming directly from the German Ocean, salt either entirely failed, or acted very injuriously, and in no one experiment produced an encouraging result,—that at Barnyards in the county of Aberdeen, a place somewhat similarly situated, no effect whatever was produced by salt as a manure,—that at Mount Annan, Dumfries-shire, near the Solway Firth, where the south-west winds will bring the spray to shore, salt produced little or no effect upon wheat, turnips, or flax, but was found useful for pasture, on which it had nearly as much effect as shell-lime,—that at Almond Myrehead, near Linlithgow, where, whatever be the direction of the wind, it must sweep over several miles of land before it can reach this spot, salt was found beneficial in every instance where it was judiciously applied, giving an increase both in measure and weight of grain, and in potatoes producing 11¼ bolls more per acre. And, in the experiments with salt published in Professor Johnstone's 'Suggestions,' the most beneficial results were obtained in the neighbourhood of Glasgow and Paisley." Every farmer, then, who would judiciously use salt as a fertilizer, particularly in any direct application of it in the way of top-dressing or of ordinary manuring, ought to ascertain as exactly as possible the natural constitution of the soil to which he intends to apply it; and should withhold it altogether, or give partial or full doses of it, according as the land receives ample supplies of it, or limited ones, or scarcely any, from sea-vapours or other natural sources. Another and all-important precaution in the use of salt as a direct fertilizer, just like a nitrate or gypsum or lime or any other special manure, is not to rely on it alone for feeding and rearing a crop, but to see that all the other requisite principles of the crop's food be present in the soil. See the article SEA-WATER.

In using salt in aid of the fallow process, for destroying slugs and larvæ and other small vermin in the field, and for assisting to disintegrate hard clods, to pulverize adhesive ones, and to mellow the whole texture of the ground, it may be sown in autumn, some time before the land is ploughed, at the rate of from 30 to 40 bushels per acre. "The salt being thoroughly incorporated with the soil during the following spring and summer," says Sir John Sinclair, "the strength of it will be so much reduced, when the seed is sown, that instead of injuring it will promote vegetation; and the lands, it is said, will be found to produce a crop superior to those under any other mode of cultivation, the advantage of which will be experienced for several succeeding years."

Salt, in suitable circumstances of place, time, and quantity, acts well upon the cereal crops. R. Legrand, Esq., sowed it on a barley tilth, at the rate of 16 bushels per acre, immediately after the crop was covered by the harrow; and he found the verdure in spring greater, and the ripened appearance in autumn many degrees whiter, than he had ever before witnessed. Mr. Hollinshead recommends the sowing of 16 bushels of salt per acre on potatoes, as soon as they are covered with earth,—and maintains that, by this means, alternate crops of them and of wheat might be permanently produced on the same soil; and though this opinion is far too sanguine, and requires to be greatly qualified, yet, when viewed as coming from a man who made scientific and practical enquiry into the uses of salt during a period of upwards of twenty years, it must be received as a strong testimony, in a general way, to the beneficial action which this manure exerts on wheat. Cuthbert W. Johnson, Esq., made comparative trials of it, on a light and gravelly soil at Great Totham in Essex; and found the produce per acre on a part which received no manure at the time, and which had not been manured for four years, to be 13 bushels and 26 lbs.,—on a part which he manured with stable dung to a crop of potatoes on the preceding year, to be 26 bushels and 52 lbs.,—and on a part which he manured with 5 bushels of salt per acre, and which had received no other manure for four years, to be 26 bushels and 12 lbs.; and he recommends that salt for wheat be applied some time before sowing the seed, in a dose of not less than 10 and not more than 20 bushels per acre. Mr. Hannam made comparative trials of salt and other special manures upon oats, barley, and wheat; and arrived at the general conclusion respecting salt, that, in the case of oats, it has a tendency to increase both the quantity and the quality of the grain, and to increase the quantity of grain in a greater ratio than the quantity of straw,—that, in the case of barley, it has a tendency to increase the quantity of grain in a greater ratio than the straw, to improve the quality of the grain, and to render the straw white and brittle and to promote its ripening,—and that, in the case of wheat, it tends slightly to increase the produce of the grain, to increase the weight of it per bushel, and to decrease the weight without diminishing the bulk of the straw, and may therefore be advantageously used as an auxiliary to other manures. The quantity he used per acre was 24 stones; and the results he obtained, comparatively with those from nitrate of soda, nitrate of potash, guano, and rape-dust, were highly favourable. See the section "Special Manures" of the article MANURE. Mr.

George Sinclair, with his accustomed scientific accuracy, and in a variety of different ways, made some important experiments, at Woburn, on the use of salt, by itself and in compost and in different quantities, as a manure for Talavera wheat, employing plots of sandy soil each 36 feet square, drilling in the seed on the 5th of November, and reaping the crops on the 2d of August; and the following tabular report of his experiments, though not at all to be taken as an index of what may be expected on larger areas, and under ordinary circumstance of field cultivation, is instructive both by showing the comparative results which Mr. Sinclair obtained, and by stating and suggesting a great diversity of methods in the application of the manure.

Kind of Manure and Mode of applying it.	Manures, omitting Fractions. Quantity per acre.				Produce.	
	Dung in Tons.	Salt in Bus.	Lime in Bus.	Oil Cake in Bus.	Bus.	Weight of a Bus.
						lbs.
Spit manure applied previous to sowing the seed	45	-	-	-	49	57½
Salt and spit manure dug in salt mixed with seed	45	44	-	-	75	58
Salt mixed with soil four inches deep before sowing	-	44	-	-	91	59
Salt ditto ditto ditto	-	5½	-	-	77	59
Salt sown with seed	-	5½	-	-	73	57
Salt combined with manure, dug in four inches deep	45	5½	-	-	75	52½
Salt and manure: salt sown with seed, manure dug in	45	5½	-	-	95	59
Salt and manure: salt applied to the surface	45	5½	-	-	82	57½
Salt simply applied to the surface	-	5½	-	-	60	55
Salt and manure: salt applied to the surface	45	44	-	-	55	53¾
Salt simply applied to the surface	-	44	-	-	77	56
Salt and lime mixed, and applied with the seed	-	5½	121	-	66	56½
Salt and lime mixed, and applied before sowing	-	5½	120	-	68	56½
Salt and lime mixed, and applied on the surface	-	5½	120	-	64	56
Lime applied with the seed	-	-	120	-	53	52½
Lime applied to the surface	-	-	120	-	57	54½
Salt, lime, and dung mixed, and applied as manure	90	5½	120	-	62	56⅓
Long dung dug in as manure	41	-	-	-	71	56½
Salt and long dung mixed, and applied as manure	41	22	-	-	71	56
Lime and long dung mixed, and applied as manure	41	-	120	-	54	57
Salt and long dung mixed, and applied as manure	41	44	-	-	-	56
Oil cake mixed, and applied with the seed	-	-	-	5½	48	56
Oil cake applied as common manure	-	-	-	5½	73	60
Oil cake and lime applied as common manure	-	-	120	5½	74½	56¾
Salt and oil cake mixed, and sown with the seed	-	5½	-	5½	60½	2
Salt and oil cake mixed, and applied as manure	-	5½	-	5½	74½	58
Salt, oil cake, and manure, applied as manure	90	5½	-	5½	74½	58
Salt, oil cake, and manure: the salt and oil cake sown with the seed, manure previously dug in	90	5½	120	5½	55½	55½
Salt, oil cake, and lime, applied as manure	-	5½	120	5½	71	51¼
Salt, oil cake, and lime, sown with the seed	-	5½	120	5½	55¼	55¼
Salt, oil cake, and lime, applied to the surface	-	5½	-	5½	66	58
Salt applied to the soil in preceding spring	-	62	-	-	44¼	57½
Salt applied to the soil in preceding spring	-	31	-	-	26½	47½

Salt acts well in many kinds of composts. Though highly antiseptic when somewhat freely applied to the surface of compact and homogeneous dead substances, yet it accelerates decomposition and multiplies the affinities for recombination when mixed in small quantity with incompact and heterogeneous dead substances; and hence it may be advantageously strewn over masses of farm-yard manure when they are carried to the field, or sprinkled, from time to time, upon accumulating heaps of the refuse of gardens and coarse vegetable matters and animal remains. A mixture of foul salt with grass roots and other rubbish harrowed off the land was long ago tried as an ingredient in compound manures, for a crop of barley and grass seeds, and found to exceed the most sanguine expectations. A mixture of salt with earths and shell sand, spread on turnip fallows, tells well both on the green crop and on the succeeding grain crop; and either this or any other application of salt, is supposed to increase the vigour and hardiness of turnips, and to enable them to withstand better the effects of frost. A compost of salt and lime, in the proportion of one measure of the salt and two measures of the lime, when properly prepared and judiciously applied, is an excellent manure for many purposes. The mixture of the salt and the lime should be made by simply intermingling them in a heap, and should either be covered with sods or kept in a shady place, and should be allowed to lie undisturbed during two or three months; and, in this way, it passes through a gradual decomposition, and resolves itself into muriate of lime and soda, and acquires an alkaline crust over its whole surface, and becomes one of the most powerful substances known for absorbing moisture from the atmosphere into the soil. Cuthbert W. Johnson, Esq., recommends it to be applied at the rate of from 35 to 60 bushels per acre, either sown out of a seed-basket, or mixed with earth and spread in the usual way; and he says respecting it, "It promises now, through the successful example of Mr. Bennett, and Sir C. Burrell, to be very generally adopted. It is difficult to account for the neglect of this manure, on any other ground than the difficulties which were so long thrown in the farmer's way, by the long continued tax upon salt. That it is not a novel plan for enriching the land is quite certain. Glauber, a celebrated German chemist, one of the last of the alchemists,

described it in the jargon of his craft nearly two centuries since; when he said.—'The sal mirabilis (common salt), as it is of itself, is, by reason of its corroding virtues, which it as yet retains, plainly unfit for the multiplication of vegetables, for that being so used would prove more hurtful than profitable. Upon this account it is necessary that to one part of it be added two parts by weight of the best calyx vine (lime), which being moistened with water and made into balls, are to be well heated red-hot for an hour, that so all the corrosivity being introverted, the sal mirabilis may be alkalizated, and used to vegetables for an universal medicine; for it conserves its attracting force, and loseth it not in the heating red-hot.' Christopher Packe, who, in 1688, published in English Glauber's folio volume, dwells at considerable length, in his preface, upon this mixture of salt and lime; 'for the enriching of poor and barren land, it is the cheapest of all mixtures, and is most easy to be done, for any ploughman having but once seen it done may be presently able to manage it.' Salt and lime was used as a manure by Mr. Mitchell of Ayr, many years since; and he, not knowing what others had done with this fertilizer before his time, considered himself to be the discoverer. He thus described his process:—'Take 32 bushels of lime, and slack it with sea-water, previously boiled to the saturated state. This quantity is sufficient for an acre of ground, and may be either thrown out of the carts with a shovel over the land in the above state, or made into compost with forty loads of moss or earth, in which state it will be found to pay fully for the additional labour, and is sufficient for an acre of fallow ground, though ever so reduced before. Its component parts are muriate and sulphate of lime, mineral alkalies in an uncombined state, also muriate and carbonate of soda. All the experiments have done well with it, but especially wheat and beans; and it has not been behind any manure with which it has been compared. There is one instance in which it was tried in comparison with 72 cart loads of soaper's waste and dung; and although this was an extraordinary dressing, yet that with this salt and lime manure was fully above the average of the field."

A mixture of salt with soot, and also mixtures of it with vegetable mould and with ditch scrapings, have produced excellent effects. "The mixture of salt with soot," says Mr. Johnson, "produces the most remarkable effects, especially when trenched into ground prepared for carrots. Mr. G. Sinclair found that when the soil, unmanured, produced 23 tons of carrots per acre, the same soil, fertilised with a mixture of only 6½ bushels of salt and 6½ of soot, yielded 40 tons per acre. Mr. Belfield describes the mixture as equally beneficial for wheat. And Mr. Cartwright found that when the soil, without any addition, yielded per acre 157 bushels of potatoes, dressing the same land with a mixture of 30 bushels of soot and 8 bushels of salt made it produce per acre 240 bushels."

"Mixtures of salt and earths," says Donaldson, "have been used with great benefit for turnips, and mixed and unmixed with farm-yard dung. The results were in every case favourable at the rate of 20 to 25 bushels an acre; and on carrots and potatoes the quantities of 13 and 9 bushels of salt were attended with very beneficial effects. In one case, 25 bushels were visibly much superior to 18 bushels on an acre; while for carrots, 6½ bushels exceeded 13½ in weight of crop under a similar application. In another set of experiments, on potatoes, we find 40 bushels of salt, one-half laid on in September, and the other half after the crop was planted, did not exceed in produce the quantity from the 20 bushels applied in September, and did not equal the usual crop from stable-yard dung alone, and that 40 bushels of salt applied with stable-yard dung did not much exceed the produce from the latter manure alone. These results are decidedly against the effects of salt; further experiments, on onions, carrots, turnips, potatoes and mangel-wurzel, showed a regular increase in the produce of all the articles, as the quantity of salt applied was diminished."

Salt has been applied to all sorts of grass lands, in various ways, in various quantities, and for various purposes, in most parts of Britain; and though very diversified in effect upon the quantity of produce, it has always, when moderately and wisely used, been highly beneficial in effect on the quality. From 6 to 16 bushels per acre have been very commonly used for the purpose of general fertilization, and have been generally found to improve both the quantity and the quality of the herbage, to kill the least refractory kinds of weeds, and to purify and sweeten the whole soil and sward; and from 20 to 40 bushels have been often used to destroy rank growths of mosses, nettles, ragworts, thistles, rushes, or other refractory weeds, and have sometimes killed for a time all the useful as well as the noxious plants, and have at other times but temporarily subdued the weeds, and proved of very small eventual efficacy. "It has been proved by experiment in Cheshire," says Sir John Sinclair, "that, after draining sour rushy land, if salt be spread upon the surface, in the month of October, its effects on the crop of next year will be in the highest degree satisfactory. In one spot, where 8 bushels were spread, a most flourishing crop of rich grass appeared in the month of May, but a still stronger crop in the month of July, where 16 bushels had been applied. In the Netherlands, Dutch turf ashes, which are strongly impregnated with saline particles, are applied to the second as well as to the first crop of clover, with great success; and Mr. Hollinshead strongly recommends sowing 6 bushels per acre on meadows, after the hay is

got in, particularly in dry and hot summers, and upon limestone and sandy soils. The moisture which the salt attracts and retains, powerfully assists vegetation, and produces a crop greatly superior in quality to that obtained by the application of dung. For meadows it is found to be an advantageous practice, to mix 16 bushels of salt with 20 loads of earth per acre, turning over the heap two or three times, that the substances in it may be thoroughly incorporated, and spreading it on the surface either in summer or spring."

The uses of salt as a manure in gardens, altogether additional to its uses in destroying slugs and worms and larvæ and weeds on lawns and gravel-walks and worked beds, are very numerous and valuable. It acts well, in the kitchen garden, for carrots, parsnips, turnips, onions, asparagus, and other similar crops; it prevents the clubbing of the roots of some of the brassicas; it promotes the vigour and beauty of all the many bulbous-rooted flowering-plants which naturally love habitats in the near vicinity of the sea; and it forms an excellent ingredient in composts for carnations and some other finely flowering fibrous-rooted perennials. A little salt dissolved in the water in which cut flowers are kept, is well known to prolong very considerably their duration; and a little salt mixed up with the compost of the flower-beds of the border and of the flower-pots of the greenhouse, might probably be found a pretty general promoter of both the beauty and the prolonged bloom of flowers.—*Hollinshead on the Importance of Salt as a Manure.—Sir John Sinclair on the Uses of Salt for Agricultural Purposes.—Hannam's Essay on Manures.—Johnson's Essay on Salt.—Johnson's Farmer's Encyclopædia.—Darwin's Phytologia.—Donaldson's Treatise on Manures.—Dana's Muck Manual.—Gregory's Outlines of Chemistry.—Turner's Elements of Chemistry.—Fennel's Use of Salt to Man and Animals.—Dacre's Uses of Salt as a Condiment, and other Papers by other authors, in the Q. Journal of Agriculture.—The Journal of the Royal Agricultural Society of England.—Transactions of the Highland Society.—Museum Rusticum.—Dickson's Husbandry of the Ancients.—Hunter's Georgical Essays.—Liebig's Chemistry of Agriculture.*

SALT MARSH. See MARSH.

SALTPETRE. See NITRATES.

SALT-TREE. See CARAGANA.

SALTWORT,—botanically *Salsola*. A diversified genus of plants, of the goosefoot family. It has inferior, five-petaled flowers, fleshy calyxes, closed and calyx-embedded capsules, and spirally embryoed seeds. One species grows wild in Britain; about 15 species have been introduced from other countries,—principally Siberia and the South of Europe; and between 30 and 40 more are known. Three of the introduced species are slightly tender evergreen undershrubs; and all the rest are curious weedy-looking annuals, varying in height from a few inches to about 3 feet.

The common or prickly saltwort, *Salsola kali*, is an annual indigen of the light sandy sea-shores of Britain. Its stems are spreading, bushy, hairy, and about a foot high; its leaves are narrow and somewhat rugged, and terminate each in a sharp bristled point, and form an armature upon the stems; its flowers are solitary, minute, and flesh-coloured, and have coloured membranous edges on their calyxes, and bloom in July and August; and its fruit are turbinated, winged capsules, filled with spiral seed. This is the best of our native plants for yielding kelp, barilla, potash, and soda; and was formerly collected, in considerable quantities, on our western coasts, and burned to yield soda for the manufacture of glass and for other purposes. Yet though it grows freely from seed, and does not require any great nicety of management, it does not seem to have ever been made the subject of careful cultivation.

The cultivated saltwort, *Salsola sativa*, is a native of Spain, and was introduced to Britain about 65 years ago, and has pink flowers, and attains a similar height to the British species. The soda saltwort, *Salsola soda*, is a native of the South of Europe, and was introduced to Britain in the latter part of the 17th century, and has white flowers, and attains a height of about 3 feet. These two species are cultivated on the light sandy soils of the northern sea-board of the Mediterranean, and particularly on the coasts of Spain, for furnishing the barilla and the soda of commerce; and they afford the best kinds of these substances anywhere used in Europe. Why has not the cultivation of them been fairly tried in Britain? See the articles BARILLA and SODA.

SALTWORT (BLACK). See MILKWORT.

SALVIA. A large genus of ornamental plants, of the labiate order. Two species grow wild in Britain; about 140 species have been introduced from other countries; and about 100 more are known. A few of the introduced species are hardy annuals; a few are hardy biennials; many are hardy perennial-rooted herbs; some are tender evergreen herbs; a few are hardy evergreen undershrubs; and some are tender evergreen undershrubs. Most have a height of between 1 foot and 4 feet; very many have either blue, scarlet, violet, or white flowers; and the great majority possess a high degree of beauty, while some are among the most brilliant ornaments of the flower-garden. A medicinal species is noticed in the article SAGE; and the two indigenous species, and two aromatic exotic ones, are noticed in the article CLARY.

The spreading species, *Salvia patens*, is one of the most beautiful, and may be selected as a favourable specimen of the whole genus. It is a native of Mexico, and was introduced to Britain in 1838. It has a perennial root, and an erect and hairy stem, and commonly attains a height of from 2 to 4 feet. The leaves are large, ovate,

or deltoid, broadly hastate or somewhat cordate, or in some cases rounded at the base, and green and hairy on both surfaces. The flowers are disposed in long terminal racemes, usually branching into three at the base; and stand in opposite pairs, each at the axil of a small linear-lanceolate floral leaf. The flower-stalks are short; the calyx is from one-half to three-fourths of an inch long, hairy, green, and deeply divided into two lips; and the corolla is between 2 and 3 inches long, of a rich deep blue colour, with a broad gaping mouth,—the upper lip long, falcate, and erect,—and the lower one pendent, and having two lateral, oblong, reflexed lobes. This is a greenhouse plant; and loves a loamy soil; and varies much in the number, size, and brilliancy of its flowers, according to the degree of light and heat in which it grows; and, if weakened, or allowed to become etiolated, is liable to suffer great detriment to its beauty by disproportionateness between the length of its racemes and the mutual distances of its flowers.

Some of the most ornamental species, are, of hardy annuals, *S. trichostemoides*, 9 or 10 inches high, carrying blue flowers in May and June, and introduced from North America in 1826,—*S. prismatica*, about a foot high, carrying blue flowers in June and July, and introduced from Mexico in 1824,—and *S. horminum violacea*, about 20 inches high, carrying purple flowers in June and July, and introduced from the South of Europe toward the close of the 16th century; of tender annuals, *S. foliosa*, about 20 inches high, carrying blue flowers at any or all seasons, and introduced from Mexico in 1827; of hardy biennials, *S. ceratophylla*, about 2 feet high, carrying yellow flowers in July and August, and introduced from Persia in the end of the 17th century,—and *S. pinnata*, about a foot high, carrying purple flowers in July, and introduced from the Levant in the former part of last century; of hardy herbaceous perennials, *S. azurea*, about 6 feet high, carrying blue flowers in August, and introduced from Carolina in 1806,—*S. grandiflora*, 2 feet high, carrying light blue flowers from June till September, and introduced from the South of Europe in 1816,—*S. virgata*, about 4 feet high, carrying white flowers from July till November, and introduced from Armenia about 90 years ago,—*S. lyrata*, about a foot high, carrying light blue flowers in June and July, and introduced from North America in the former part of last century,—and *S. crassifolia*, about 2 feet high, carrying blue flowers in June and July, and introduced from the South of Europe about 44 years ago; of greenhouse herbaceous evergreens, *S. amarissima*, about 2 feet high, carrying blue flowers in July and August, and introduced from Mexico about 45 years ago,—and *S. pulchella*, about 2 feet high, carrying scarlet flowers throughout winter, and introduced from South America in 1821,—and *S. mexicana*, about 2 feet high, carrying scarlet flowers from May till July, and introduced from Mexico in the former part of last century; and of greenhouse ligneous evergreens, *S. aurita*, about 2 feet high, carrying blue flowers in May and June, and introduced from the Cape of Good Hope toward the end of last century,—*S. formosa*, about 4 feet high, carrying scarlet flowers from spring till the latter part of autumn, and introduced from Peru about 65 years ago,—*S. fulgens*, 4 or 5 feet high, carrying scarlet flowers from May till October, and introduced from Mexico in 1829,—and *S. confertiflora*, 3 or 4 feet high, carrying bright red flowers in autumn, and introduced about 12 years ago from the Organ Mountains of Brazil. But some of the unintroduced salvias are believed to be fully equal in beauty and splendour to the finest of the introduced ones; and probably so many as one hundred species or upwards, from America alone, may eventually be found well worthy of cultivation in the flower-garden. A curious hardy herbaceous species, which was introduced about 50 years ago from Germany—*S. glutinosa*, about 3 feet high, and carrying yellow flowers from midsummer to mid-autumn—is used in some districts of Switzerland for entangling and removing disagreeable insects, either by spreading the plants under beds, or by making them into a broom, and drawing this slowly and gently along the floor.

SALVING OF SHEEP. The application of a salve to the skin and wool of sheep, in order to destroy vermin, and to afford protection from the weather. The name given to it in Scotland is smearing. It is practised chiefly upon the mountain breeds,—and more upon the blackfaced breed than upon the Cheviots,—and more upon the Cheviots than upon the improved cross-breeds. The salve should be thick enough to be capable of being taken up by the finger, and at the same time thin enough to be easily rubbed off when drawn along the skin; and it is most facilely and efficiently applied while the sheep lies upon a stool of just suitable breadth and length to contain its outstretched body, and while the operator sits astride upon a narrow projection from one end of the stool. The wool is parted longitudinally into rows, without a pile being allowed to lie across them; the salve is applied directly to the skin along each bared row; and the rows should be perfectly parallel to one another, and at such distances that the deposition of salve along each may reach through the bottom of the piles to the deposition along the next, so that the whole skin may be equally salved and every individual pile anointed. No portion of salve, however, ought anywhere to touch the wool except at its roots. An experienced operator can salve from twenty to twenty-five sheep in a day.

"Salving," says the editor of the Quarterly Journal of Agriculture, "was most probably first adopted with the view of healing or preventing that vile cutaneous disease called scab,

and of destroying vermin. From the treatment that sheep received in this country until a comparatively recent date, it is probable that that disease was of usual occurrence every spring. Sheep got leave to traverse the pastures all winter without shelter, and with no food but what they could pick up from coarse grasses, or what they could scratch up from under the barest patches of snow. When the pasture revived in spring, the condition of the sheep recovered, and the recovery was sudden, and thereby attended with eruption on the skin. The constant and uneasy itching occasioned by the scab impelled the sheep to rub themselves against any object that presented itself in the most convenient form for the purpose; and the consequence of the rubbing was the tearing off, in shreds, the fleeces long before the season for clipping arrived. According to the authority of Culley, fine-woolled sheep existed in Scotland before the introduction of the coarse-woolled blackfaced breed; and as there would of course be a natural desire to preserve the fleece from such destruction, salving became the proposed remedy. Another remedy of a more natural character was, perhaps, simultaneously proposed, and that was the introduction of a hardier race of sheep, whose fleece could withstand the bleaching effects of rain, and the chilling effects of storm better than the fine-woolled old breed, and hence the introduction, it is said, of the blackfaced breed into Ettrick Forest, by one of our Scottish kings. But even they, with all their hardihood of constitution and coarseness of wool, were found unable to withstand the inclemency of the winter storms in our hills; and hence smearing was resorted to with them as well as the older fine-woolled breed. But what was the best salve to apply for the purpose? Tar, it was thought, would mat the wool together and keep out cold; and grease, it was conceived, mixed with it, would mollify its astringent effects both on the wool and the skin. And so this smear of tar and butter has long been used for the purpose; and to make it as cheap as possible, filthy salted and adulterated butter has been imported from Germany to mix with the tar. The salt in this butter deliquesces, and keeps the wool always in a raw damp state. The smearing with this stuff was so long persevered in, that the manufacturers will no longer buy the clotted stuff called 'laid wool,' but at a great reduction of price. In that state the wool is found altogether unfitted, from staining, for the manufacture of white goods; and even when washed as well as can be, it resists the more brilliant dyes to which it may be subjected. On this account, many expedients have been devised to dispense with the use of tar and salt grease-butter, and to substitute something possessing the adhesive properties of tar and the emollient properties of butter. The objects chiefly aimed at in smearing sheep, now that they are kept tolerably free of the scab, is the protection of the animal from cold, the destruction of the vermin which at times infest them, and the increased growth of the wool,—all desirable objects undoubtedly; but the question is, can these be best attained by salving or other means?

"The answer to this question requires some consideration; but the analogy derived from the management of sheep in the low country may assist us to a satisfactory one. In the first place, there can be no doubt that, were the winter-pastures of hill-sheep sheltered as they ought to be, the sheep would require no other protection from the weather. The rain, as things are, no doubt, washes away the natural grease from the wool and renders it harsh, which the grease of the salve tends to soften; but were the sheep sheltered by means of plantations, the rain would not have the same power to deprive the wool of its natural grease. There is another condition in the management of sheep which would supply an adequate quantity of natural grease to the wool, and that is by keeping the sheep always in a fair condition. This could be accomplished by a plentiful supply of good food in hard weather, consisting either of meadow-hay, which might be obtained by means of irrigation in every valley among the hills; or, by associating arable farming with hill-pasturage, turnips could be raised to support the sheep in winter along with the meadow-hay. Is it not better to supply grease to the wool in the natural way, through the skin, than by any artificial application upon the skin? and would not a fair condition of the carcass supply an adequate quantity of natural grease?

"But it may be objected to all this, that the proposed management of hill-sheep would be attended with great labour and expense. No doubt the first attempt of the plan would be attended with much trouble and a good deal of expense; and on that account it should chiefly be undertaken by landlords or by tenants of capital effecting it under encouraging leases. But we would ask in return, has the plan ever been attempted? and if not, how can it be known that it is one which would not repay the cost? Would 5s. be considered an extravagant increase of the price of a carcass of mutton, after being better fed than it has hitherto been accustomed to? and would 2s. a-fleece be considered an exorbitant increase of price, were the wool improved in quality and presented in such a state as is desiderated by the manufacturer? Would not, therefore, 7s. a-head increase of value over the many thousands of sheep which depasture on our mountain-ranges, afford to cover a good deal of extra expense in sheltering and feeding them with plenty of food in winter? And would not the proper shelter of pasture in winter very much improve it for the summer? The lesson derived from the successful management of sheep upon the plains should not be neglected. It

warrants us in believing that hill-sheep could be maintained in condition, and that without smearing, though some application at stated times seems necessary to destroy the vermin on sheep. Indeed, we are convinced, that were this plan but partially adopted at first, it would soon show the practicability of maintaining finer woolled sheep upon our mountain-pastures, and of their superseding the coarse-woolled variety altogether.

"But until these changes are effected, and they will be some day we have no doubt, smearing, we suppose, must be persevered in; and the question that most concerns us in the mean season is, what is the best sort of salve for sheep, that is to say, what sort of salve will best protect sheep from the chilling effects of rain and snow,—which will most easily destroy the vermin on sheep,—and which will best encourage the growth of wool, and at the same time preserve it in a soft state, and free from all stain? To ascertain these important points, the Highland and Agricultural Society has offered a premium for the best account of a comparative trial of two kinds of salve,—first, one made of crude white arsenic, butter, soap, turpentine, &c.; and, second, another of white tar, which is common tar, deprived of its colouring matter, and cocoa-nut oil, mixed in the proportion of common tar and butter. We believe that favourable accounts of the safe application of both these salves have been received by the Society. For our parts, we have so utter an antipathy to the use of arsenic, in any shape, about a farm-steading,—and the precautions advised to be adopted in the use of it, to prevent its entering the eyes, ears, and mouth of sheep, show there is danger in using it,—that we would not use it, nor advise any one to use it, on any account, however beneficial its effects may be proved to have been; and besides, we are not satisfied, on the common sense view of the thing, that the application of any mineral substance can be beneficial to wool, however it may preserve or even improve its natural colour. With regard to the white tar-salve, we have heard from extensive store-masters, that though it keeps the wool free of discoloration, and in this respect is superior to the common tar, the wool gives a very light clip wherever it is used."

"All the European tars, especially that from Norway," says Mr. Hogg of Stobohope, "have been remarkable for their blackness, strength, and drossiness. This last adjunct is not discernible till the finer and more soluble part of the tar has, along with the greasy part of the mixture, and by the heat of the animal's body, been diffused round the carcass. It then appears in a clammy, clotted condition among the wool, where it rests till spring. The heat of the season now dries it into a mouldering state; and it is principally this tarry dreg which gives that zone of pollution to the fleece for which tarry wool is so much hated. But this dirty sediment, though detestable in its final consequences, is the main material which closes the wool, and keeps it firm and compact round the animal in the greatest tempest. When the American tar began to be used, it was whiter, milder, and softer, not so searching for the constitution, and far more free from sediment than that from the north of Europe; but just as the store-master was about to make this tar the basis of a smearing composition, the country was all at once inundated with white new salves, sundry of them containing no ingredient which could be serviceable either for sheep or wool. The materials of others were purposely kept a secret, the inventor persuading himself he would make a fortune by the discovery; but, alas! they have scarcely maintained a character for one year. Yet there is no want of a new supply; for, like the many-headed hydra, no sooner is one dismissed as useless, than another starts up in its place, generally with some epithet in its designation expressive of superiority. * * * Except with the excessively parsimonious or careless store-master, the new, white, cold mixtures never can come into use as salves for smearing. With the former, the cheapness of the materials and the facility with which they can be applied, will, no doubt, be an inducement for their continuation; with the latter, that natural apathy or sluggishness, which disposes to neglect other improvements, will also induce him to disregard this; but by the judicious, the active, and the anxious store-master, they cannot be long employed in the form in which they are at this time presented. Every one of them, without exception, is destitute of any ingredient, or at least contains it in very small quantity, which is calculated to close the fleece previous to the setting in of winter; and the principal benefit derived from smearing is keeping the animal warm and comfortable during the rigours of that season. To make this more obvious to the inattentive farmer, I may observe that nature does a great deal in furnishing the animal with wool preparatory to the setting in of winter. It grows in that direction, and in the appropriate quantity, where the wearer needs it most for defence and clothing; and each pile of wool, as it grows (at least in a thriving sheep), is anointed with an unctuous oily secretion, which holds every fibre of wool in its place and beside its fellows. This natural cement is sufficient to throw aside the rains and mists which, through summer, visit all alpine pastures; but, for the snow drift, incessant rains, and tempests of winter, it is insufficient as a defence; and the artificial unguent, composed and applied by man, comes to its assistance. This extinguishes the natural oil; and, by imperceptible advances, at least if a sheep is rightly smeared, creeps to the top of every pile of wood; and, if it have not some tenacity in its composition, it is good for nothing—nay, it is worse; it

destroys the natural juice in the wool, and is incapable of again closing it against winter. By the destruction of the natural yolk, the filaments of wool have not only lost their original connection, but, in order to deposit the artificial salve, the wool must be perfectly and completely opened to the bottom, where the thin white salves are employed. This opening never again closes up. The superior flakes of wool, indeed, overlie the inferior; but they never coalesce and intermingle as they did formerly. From these statements may be inferred the extreme necessity there is for using a right salve, or one which will keep the poor creature warm and comfortable through winter; and its wool being rendered compact and firm around it, contributes more to this purpose than any other means which can be employed."

"As a remedy to many of the evils incident to the prevailing modes of salving sheep," said Mr. Robert Boyd, of Innerleithen, in 1843, "Mr. Ballantyne of Holylee, a zealous labourer for the improvement of the fleece, has, for the last two years, salved his flocks, which amount to upwards of 163 scores, with the following composition:—

30 lbs. of butter, ...	5d.	£0	12	6
14 " rough turpentine, .	1½d.	0	1	9
3 " black soap, . . .	4d.	0	1	0
2 " soda ash, ...	1d.	0	0	2
5 bottles refined spirit of tar,	7d.	0	2	11
		£0	18	4

To this 21 pints of water are added, to assist in the equal spreading of the mixture. The above composition is found sufficient to salve 100 sheep, which is at the rate of 2¼d. a-head. It requires to be applied to the fleece at a temperature a little above blood-heat. When we consider the chemical nature of this composition, it will appear that the most appropriate name which can be given to it, as a new salve, is 'artificial yolk,' for it is of the same nature, and possesses the same properties, as the natural yolk existing in the wool. It is known that the conducting powers for heat, both of animal and vegetable oils, are very materially diminished when saponified; this is owing to the compound being thus rendered porous. The soda-ash contained in the above composition has the effect of saponifying the whole mass; consequently, the conducting power for heat of the animal oil contained in it is greatly diminished, and a degree of comfort obtained for the animal to which the composition is applied which could not result from the use of oils which had not undergone the process alluded to. It was supposed by some that, owing to the saponaceous nature of this composition, it would, in some measure, be liable to be washed off by rain. This, however, has been proved not to be the case; for it was found, on the strictest examination, that no aqueous matter had been able to penetrate the fleece during its growth. Mr. Ballantyne considers the artificial yolk salve decidedly superior to any other he has ever used as a defence to the sheep. In addition to this, it is calculated, in my opinion, to produce a fleece unequalled in the history of salves. In this estimate of its value, I have the concurring testimony of Mr. Barff, wool-stapler, Wakefield, whose extensive experience entitles his opinion to great weight. He has been the purchaser of Holylee clip for the last twenty years; and he affirms that the salve used by Mr. Ballantyne for the last two years has had the effect of producing upon the fleece an indescribable kindliness to the touch, and that its felting properties were also very materially improved. In consequence of these advantages, he has allowed Mr. Ballantyne the highest price he gives for the purest unlaid wood, which is the best evidence that can be adduced of his high opinion of its value. It may be further added, that the opinion of the English wool-staplers appointed to decide upon the merits of the Leicester fleeces, shown in competition at Edinburgh in 1841, was expressed in terms of commendation in reference to the fleeces in question."

SAMBUCUS. See Elder.

SAMOLUS. See Brookweed.

SAMPHIRE,—botanically *Crithmum*. A small genus of herbaceous plants, of the umbelliferous order. The common or sea samphire, *Crithmum maritimum*, is a perennial-rooted indigen of the coast-rocks and sea-cliffs of Britain. The root comprises many strong fibres, which penetrate deep into the crevices of the rocks; several fleshy, succulent, leaf-garnished stems rise from the root to the height of 12 or 20 inches; the leaves are twice ternate, and stand on sheathing footstalks; the leaflets are lanceolate, acute, fleshy, and nearly half an inch long; and the flowers are produced in dense circular umbels at the top of the stems, and have yellow anthers and white petals, and bloom from July till September. This plant has very long been in high request for making an agreeable pickle, and provoking an appetite for food, and has also the reputation of being a diuretic and of removing obstructions of the viscera. It commonly grows on spots which cannot easily be reached; and is often gathered by poor peasants or fishermen, who scramble perilously on the cliffs, or are still more perilously let down by ropes; and, at a time when it was regularly supplied to the markets of large towns, it was frequently and even commonly substituted by plants which resemble it in appearance but are totally destitute of its good properties. Some serious consequences have followed the practice of pickling and cooling it in copper pans. It cannot without difficulty be preserved in gardens, and will nowhere grow so vigorously in them as on sea-cliffs, yet may be kept for some years, and made to thrive tolerably well, by being planted on a moist gravelly soil. It can be propagated either by radical division or from seeds.

SAMPHIRE (Marsh). See Glasswort.

SAMPHIRE (Prickly),—botanically *Echinophora spinosa*. An indigenous evergreen herb, of the umbelliferous order. It occurs on the sandy sea-shores of some parts of England; but is exceedingly rare. Its root is long, fusiform, and fleshy, and has the flavour of a parsnip, and possesses stimulating and diuretic properties; its herbage is glaucous and finely downy, and branches profusely, and spreads 2 or 3 feet on all sides; its leaves are rigid and doubly pinnatifid, and have entire, awl-shaped, spinous leaflets; and its flowers are white and bloom in July.

SAMPLE. A small quantity of grain or of any other commodity, exhibited at a public or a private market, as a specimen. See the article Market.

SAMYDA. A genus of ornamental, tropical, evergreen, calyciflorous shrubs, constituting, with the genus Casearia, the natural order Samydeæ or Samydaceæ. They have alternate, stipulate, entire leaves, covered with pellucid dots,—and axillary flowers, of no great beauty,—and fruit of somewhat similar structure to that of the Bixineæ and the Flacourtianeæ. Eight or nine species of Samyda, varying in height from 3 to 8 feet, and most producing white or greenish flowers, and all propagable from cuttings, have been introduced to the hothouse collections of Britain; and about as many more are known.

SAND. Disintegrated, granular, mineral matter. It results either from the separate deposition of silicious substances in the course of the formation of alluvium,—or from the mutual attrition of fragments of granular rock under the running action of water,—or from the comminution and commixation of corals, shells, and boulders under the littoral refluxions of the sea. Some vast beds of it belong to remote geological periods; and others are in constant course of deposition at the present day.

Sand is exceedingly diversified in constitution; it cannot be logically distinguished from other finely divided mineral deposits, such as clay and chalk, by any less general character than merely its granular or crystalline and incoherent structure; it possesses every variety of composition which could result from the disintegration of the most opposite kinds of granular minerals, and from the deposition of their water-worn debris under the most widely different circumstances; and it is in some places chiefly silicious,—in others, largely argillaceous,—in others, largely calcareous,—and in others, a combination of any of these characters either with one another, or with the multifarious earths and organic remains which commonly abound in alluvium. Yet any considerable intermixture of argillaceous matter, makes it nearly allied to loam; any considerable intermixture of calcareous matter either makes it nearly allied to marl, or gives it the name of shell-sand; any considerable mixture of other earths or of organic remains, either makes it nearly allied to alluvium, or gives it the name of sandy soil; and only when it consists very predominantly or quite characteristically of silicious matter, does it constitute ordinary or tolerably pure sand,—and then, not only is it granular and incoherent, but it consists, in fact, of irregular quartz crystals, and has a near relationship to flint. See the article Silex.

Silicious sand is often classified, for economical purposes, particularly for those of the farm, into sea sand, river sand, and pit sand. Sea sand, except when it possesses such an intermixture of calcareous matter as not to be strictly silicious, is generally the worst for any purpose; river sand is commonly good for some kinds of mason work; rivulet sand, but especially sand from the gentle washing of roads, is often the best for applying manurially to land; and pit sand is so exceedingly diversified in constitution as to be, in different specimens or in different circumstances, either good, bad, or indifferent for almost any use to which silicious earth is applied. Most alluvial or loamy or argillaceous or calcareous sands are well fitted to act as fertilizers when used with due discrimination; yet some are so ferruginous or slaty or otherwise infertile as to be either useless or positively pernicious.

Sand-drift, in both its silicious and its calcareous varieties, and in both its loose and its consolidated states, is sufficiently described in the article Downs. A vast tract of moving and destructive sand-drift on both sides of the embouchure of the Garonne, in the south-west of France, was reduced to fixture, in the early part of last century, by the simple expedient of flanking it with a great breadth of young plantation of the *Pinus maritima major;* and a considerable and desolating tract, on the north-west coast of Ireland, was converted, not very many years ago, into actual profitable pasture for both sheep and cattle, by the still simpler expedient of planting it, in small rectangular holes, with little fan-shaped tufts or bunches of the sea-reed or mat-grass variously known as *Arundo arenaria, Psamma arenaria,* and *Ammophila arundinacea.* The sea-reed, in fact, is the best known binder of sand-drift; the *Elymus arenarius* is next to it; the *Carex arenarius* is next; and then follow *Agropyrum junceum, Festuca rubra, Galium verum,* and *Trifolium repens.* See the article Arundo.

Sand lands or pure sandy soils are such as consist very predominantly of silicious sand. They are either whitish, blackish, reddish, yellowish, or greyish; and they vary, in the size of their granules or the comparative comminution of their substance, from mere dust to absolute gravel,—but, in general, have a medium texture between these extremes. The black, the grey, and the ash-coloured are the most infertile, and occur principally on heaths, on commons, and in absolute deserts. Arable sand lands, when wet, feel firm under the foot, and are harsh and grat-

ing to the touch, and admit of being ploughed into tolerably coherent furrow-slices; but when dry, feel soft to the tread, and are dissipative to the touch, and yield beneath a very small weight, and are liable to be blown away with the wind. All sand lands acquire a high temperature in summer, and are exceedingly irretentive of moisture; and many naturally abound in bents, heaths, quick grass, sorrel, broom, and furze. The best means of improving them are copious intermixtures of marly or argillaceous earth; and the crops most suitable for them are carrots, parsnips, turnips, rye, and oats. See the articles MANURE and SOIL.

Sand, of a silicious kind, particularly such as is washed from hills and roads and found in the bed of rivulets, is an excellent application for rendering clay soils loose and friable; and, when used as litter in cattle sheds, or as a carpeting for fold-yards, or in any other capacity which causes it to be saturated with liquid or semi-liquid excrements, forms a very good manure for most kinds of cold stiff land. But, as a mere textural improver, it requires to be as thoroughly as possible incorporated with the soil, and always does best when either itself or the clay to which it is applied contains some proportion of calcareous earth; and as a litter for cattle-sheds and fold-yards, it is often inconvenient on account of its weight, and always does best when it contains so large a proportion of clay or of vegetable remains as to be far more truly a loam or a mould than a sand.

Shell sand, or calcareous sand, abounds in many parts of the eastern, southern, and south-western shores of England, of the southern and south-western shores of Ireland, and of the western shores or western islands of Scotland. It differs much in colour, and in quality, and in the circumstances under which it is found or can be obtained by farmers. Some kinds of it are a finely comminuted dust, scarcely distinguishable in appearance from the most powdery sorts of drift-sand or of sandy soil,—and other kinds are more or less granular, or even contain intermixtures of bits of shells and small boulders. Some are in a very large degree or even mainly calcareous; and others contain great proportions of silicious and argillaceous and other earths. Some appear to derive their calcareous matter entirely from the fracture and crumbling of shells of the present epoch; and others seem to derive more or less of it from calcareous marine deposits, or calcareous marine formations, either molluscous or coralline, of comparatively remote geological periods. Some lie loose and dry and perfectly accessible along the beach; and others lie always within low-water mark, or even under considerable depths of the sea, and can be procured only by dredging.

Calcareous sand, in almost all its varieties, is a valuable manure for clay soils, heavy loams, and spongy and mossy lands, and an excellent top-dressing for rough sour pastures and meadows. It also does well to be mixed in composts for lighter soils; and may, in some cases, be very advantageously used for littering cattle, or strewing folds and sheds. "An economical use of shelly sands, separately or in composts, may be recommended in laying the manure on leys one year before ploughing, that it may have time to raise a grassy sward, and get fixed and incorporated with the surface among the roots and fibres. An application to wheat fallows has been recommended; in that case, it should be applied late in the season of working the land, and be lightly covered."

A valuable calcareous sand is extensively employed in Brittany under the name of marl, and consists principally of the remains of shells, madrepores, and corallines, but also contains a small proportion of highly azotised organic matter, and of course is, on that account, all the more mightily fertilizing. It occurs in great abundance at the mouths of the river of Morlaix; and is there the subject of a considerable traffic; and is obtained by dredging from barges, between the middle of May and the middle of October; and is said to be reproduced from time to time in a constant series of new banks. It is applied to light dry soils in doses of from 5 to 6 tons per acre, and to clayey lands in doses of 11 or 12 tons; and it requires to be used as soon as possible after it is taken from the sea,—for, when long exposed to the air, it suffers disaggregation, and loses a portion of its good qualities.

Shell sand, of very similar constitution to that of Brittany, abounds in some parts of the sea-margin of Cornwall and Devonshire, and has for many ages been appreciated by the farmers of the adjacent sea-boards. A vast and seemingly inexhaustible supply of it occurs in the estuary of Padstow; and was formerly carried some miles into the interior on horses' backs and in carts; and is now transported to greater distances and in ampler profusion by railway. This rich deposit was declared free from toll for the use of farmers, by a public document of the 13th century; and again was pronounced by a statute of the seventh year of James I., "to be very profitable for the bettering of land, and especially for the increase of corn and tillage within the counties of Cornwall and Devon." The sand is dug out of the shallows of the estuary, and carted thence to the shore, and heaped up there in large depots for transportation into the country; and from one point, at Wadebridge, it is carried into the very heart of Cornwall, and distributed off in two branch directions, by a railway which was planned and executed mainly or almost solely for the purpose; and it has, in consequence, become diffused far and wide as an ordinary manure over the county, and has produced the most extraordinary effect on the fertility of its surface. Mr. Herapath has furnished the following account of the sea-sand, felspar,

and corallines of Devonshire to the 'Pharmaceutical Times':—"The calcareous sea sand which collects in vast quantities in many parts of the Devonshire and Cornish coasts is, as is well-known, most extensively employed by the agriculturists of those counties as a manure. In such high estimation, indeed, is this sand held than many thousands of tons of it are annually conveyed from the sea-side to be applied to the lands in the interior. It is generally preferred by the farmers to cart away directly after the receding of the tide, when it is completely saturated with the sea-water, the salt of which must, of course, materially increase its value as a manure. It has been found by them to produce the most beneficial effects on close clayey soils, which it opens and renders more porous, and thus enables the water and atmospheric air to have a freer access to the roots of the plants, and, at the same time, facilitates the drainage of the land. The sand which I subjected to analysis was obtained from Barracaine, a small cove within a few miles of Ilfracombe. It contained in a 100 parts:—

Water	0·500
Soluble salts, consisting chiefly of chloride of sodium, sulphate of soda, and magnesia, with minute traces of potash	0·300
Organic matter	2·420
Carbonate of lime	47·438
Carbonate of magnesia	0·097
Sulphate of lime	Very minute traces.
Phosphate of lime	0·025
Oxide of iron Alumina	0·460
Sand, silica, and debris of slatey and granitic rocks	48·760
	100·000

Twenty grains of the sand when burnt with potash and lime gave of ammonia chloride of platinum 0·58 grs.—0·1845 per cent. of nitrogen —0·2240 grs. of ammonia. The traces of potash observed in the soluble salts were without doubt derived from the decomposition of the felspar, of which a pretty large proportion of the substances insoluble in hydrochloric acid consisted. This felspar would become gradually disintegrated by the combined influences of air and moisture, and yield up its potash to the soil, which it would improve to that extent, rendering it better suited for the cultivation of grain crops. A fine specimen of this mineral, from the same locality, was found upon analysis to consist of

Silica	64·109
Alumina	19·013
Lime	0·500
Magnesia	Very minute traces.
Oxide of iron	traces.
Potash	16·277
	99·899

By acting upon some of the same felspar partially decomposed and in fine powder with boiling hydrochloric acid, &c., as recently proposed by Fownes, I was enabled to verify the statement of that gentleman with regard to the presence of phosphoric acid in this mineral. Evident traces of the acid could be detected in 500 grains of the powdered mineral. The carbonates of lime and magnesia, and phosphate of lime, contained in the sand, are principally derived from comminuted shells and corallines, as may be easily proved by an ocular examination. Some specimens of the corallines from Budleigh Salterton, on the same coast, were found to contain in 100 grains as follows;

Soluble salts	traces.
Organic matter	9·040
Carbonate of lime	84·257
Carbonate of magnesia	1·373
Sulphate of lime	traces.
Phosphate of lime	0·100
Oxide of iron	0·820
Silica and sand	2·400
Fluoride of calcium	minute traces.
Water and loss	2·010
	100·000

Twenty grains, when burnt with potash and lime, gave of ammonio-chloride of platinum 2·17 grs—0·689 per cent. of nitrogen, or 0·837 gr. of ammonia. These corallines are now very largely employed in commerce in the manufacture of Barkers' patent sub-marine manure, of which they form one of the principal constituents. Previously to mixing them with the sea sand, night-soil, decayed fish, &c. which compose the other ingredients of this manure, they are heated with about an equal quantity of common salt, which effectually disintegrates them, and renders their constituents in a more fit state to be assimilated by plants."

A sand somewhat similar to that of Padstow is employed by the farmers of the north-east of Norfolk; and is much appreciated as an immediate and durable fertilizer of clay soils. An enormous and continually renewing deposit of calcareous sand, probably as much of very ancient as of modern origin, and everywhere so comparatively free from admixture as to seem entirely composed of powdered shells, comminuted corallines, and dust-like organic matter, extends along a large portion of the great outer Hebridean group known as the Long Island; but has as yet been comparatively little used for manurial purposes; and, in many great tracts, it has even drifted itself so freely and lightly and prodigiously over a vast extent of the poor, thin surface of the low, bleak, tempest-lashed islands, as to annoy and bewilder the landowners in nearly the same way as the west-of-Ireland sand-drifts. A large deposit, of great value, and very favourably situated along a finely arable seaboard, extends over a great part of the south-western sea-margin of Ireland. A deposit, somewhat remarkable for being on the east coast of Scotland, and for containing some intermixture of pretty large stones, both silicious and argillaceous, occurs on the sea-beach, near Gosford, in East Lothian. "In the greater part of the

Hebrides, Inner and Outer," says Mr. Clark of Ulva, "shell sand is to be found; and if used along with the kelp weed which there abounds so very much, crops of potatoes, bere, and oats might be raised more than sufficient to supply the wants of the dense population of these islands, and render them independent of the supplies of meal which they annually import from the Low Country." Transportations of it, either from entirely barren districts, or from districts where it is little appreciated, to some fine agricultural districts at even such remote distances as 150 or 200 miles, might in many instances be found both enriching to the proprietors and promotive of the general interests of agriculture; and such a traffic on a small scale, and to comparatively short distances, was begun a number of years ago, in some parts of the Hebrides.

Sea-sand of an entirely different kind from all ordinary calcareous sand, yet scarcely inferior to it in fertilizing power, occurs in some low and slightly sloping beaches which are rich in cockles, mussels, and other molluscs. This sand of itself may be principally silicious; but it contains so considerable a proportion of organic matter, and particularly of broken shells and living molluscs, as to be more or less powerfully manurial. A sand of this sort is used, with excellent effect, by the farmers all around Morecambe Bay, as a material of composts for their wheat and barley crops,—commonly in the proportion per acre of about 26 small one-horse carts of the sand, about 4 of lime, and about 10 of farm-yard manure.

SANDAL-TREE,—botanically *Sandoricum Indicum*. An Indian, white-flowered, evergreen, timber-tree, of the order Meliaceæ. It constitutes a genus of itself. It has naturally a height of about 40 or 45 feet.

SANDAL-WOOD,—botanically *Santalum*. A genus of exotic, ligneous, monochlamydeous plants, constituting the type of the natural order Santalaceæ. The plants of this order are either trees or shrubs or herbs, with inconspicuous and uninteresting flowers; and most are natives of India, Australia, and Southern Africa,—and the rest of Europe and North America. Six or seven hardy herbaceous species, 7 or 8 hardy ligneous species, and 8 or 10 greenhouse and hothouse species have been introduced to the gardens and botanical collections of Britain. Only 3 or 4 of the introduced species belong to the sandal-wood genus; but one of these, *Santalum album*, is the most interesting in the whole order. This plant is a tall evergreen shrub, or small evergreen tree, of India; and furnishes the well-known white sandal-wood of commerce. This wood has a slightly bitter taste, and a sweet aromatic flavour; and possesses mild sudorific properties; and is in considerable request as a perfume. It is used by the people of India, also, for a variety of medicinal purposes, and as a material for small articles of fancy cabinet-work.

SANDBOX-TREE. See Ajuapar.

SANDCRACK. A perpendicular crack or fissure on the side or quarter of the horse's hoof. In the fore-feet, it almost always occurs on the inside, on account of that part being the weakest; and in the hind-feet, it sometimes or even commonly occurs in the toe. In some cases, it does not extend to the sensible parts; and in others, it somewhat strongly affects them, and causes considerable lameness. It arises sometimes from a constitutional or a temporary brittleness of horn,—sometimes from such a tread or other injury as impedes the secretion of the horny matter of the hoof,—and very generally, in the case of the fore-feet, from such an unnatural elevation of the toe as occasions the horse, in acts of special exertion, to make a great pressure on the point at which the crack occurs. The common therapeutic treatment of it is to separate the divided part of the hoof from the growing part with a rasp or a firing-iron, and, i no inflammation be present, to seal up the place with some pitchy compound, and to chamber out the substance immediately beneath so as to produce relief from the pressure of the shoe. But Mr. Blaine recommends, as an additional means of completing the cure, and of preventing the formation of a new crack or disjunction before the growth of horn is perfected, to smear some melted shoe-maker's wax all over the hoof,—to bind neatly, evenly, and firmly upon it, while it is yet liquid, about 3 yards of tape, in such a way as to include as much of the hoof as may be within the turns,—to fasten off with a hard knot,—to smear the whole over again with more wax,—and to smooth it all to an even surface, and rub it over with a little lard or other greasy substance.

SAND-DRIFT. See Sand and Downs.

SANDERLING. A genus of birds of the longirostrous family of Grallæ. They are closely allied to the sandpipers, but have no thumb. The common species, *Calidris arenaria* or *Charadrius calidris*, is somewhat plentiful on the sandy seashores of Great Britain and Ireland. Its length is about 8 inches. In winter, its plumage is a very light ashy grey above, white in front and underneath, and blackish varied with white in the wings; and in summer, the back is spotted with fawn-colour and black, and the breast is dotted with blackish colour. This bird frequents the sea-margin, and feeds on shrimps, sea-worms, and slender crustaceæ.

SAND-LAND. See Sand and Soil.

SAND-MARTIN. See Martin.

SANDPIPER,—scientifically *Tringa*. A genus of birds of the longirostrous family of Grallæ. Their bill is depressed at the end, and commonly not longer than the head; their nasal fossæ are very long; their slightly bordered toes are devoid of membranes at the base; their thumb can scarcely reach the ground; and their whole figure is comparatively short, and their legs moderately long.—The canute or common sandpiper, *Tringa*

grisea, is a well-known inhabitant of the sandy sea-shores of Britain. Its winter plumage is ash-coloured above and white beneath, and has blackish spots on the front of the neck and the breast. Three other species are *Tringa islandica*, with summer plumage, spotted above, fawn-colour and blackish,—*Tringa nævia*, about as large as a snipe, with the coverts of the tail always white striped with black,—and *Tringa maritima*, somewhat smaller than the preceding, with grey upper surface, blackish mantle, whitish belly, and whitishly undulated wings.

SANDSTONE. See FREE-STONE.

SANDWORT,—botanically *Arenaria*. A genus of ornamental plants, of the carnation family. Six species grow wild in Britain; about 70 have been introduced from other countries, principally Continental Europe and Western Asia; and about 90 more are known. A few of the introduced species are hardy annuals, principally with purple or red flowers; and a great majority of the others are hardy, evergreen, herbaceous perennials, almost all white-flowered and between 2 and 8 inches high.

The mediate sandwort, or sea-spurrey sandwort, *Arenaria media*, is an annual weed of the sea-coasts and salt-marshes of Britain. The root is fusiform; many succulent, leafy-stems of 3 inches or so in height, arise from each root; the leaves are convex and smooth; the flowers are minute and of a purple colour, and bloom in July; and the seeds are flat, round, and smooth, and have a membranous border. This plant possesses a considerable resemblance to samphire; and is sold and pickled, in considerable quantities, as a substitute for it.—The vernal sandwort, *A. verna*, is a perennial-rooted evergreen herb of the mountains of Britain, and has a length of about 3 inches, and carries white flowers from May till August.—The fine-leaved sandwort, *A. tenuifolia*, is an annual weed of the sandy fields of some parts of England, and has a height of 5 or 6 inches, and carries white flowers in June and July. Three varieties of it have been introduced from France.—The fascicled or fastigiate sandwort, *A. fasciculata*, is a curious annual weed of the mountains of some parts of Scotland, and has a height of about 6 inches, and carries white flowers in June.—The red sandwort, *A. rubra*, is an annual indigen of sandy fields in both England and Scotland, and is smaller than even the mediate sandwort, and carries purple flowers from June till August.—The larch-leaved sandwort, *A. laricifolia*, is a herbaceous, evergreen perennial of Britain, and has a height of about 3 inches, and carries white flowers in August.

SANGUINARIA. See BLOODWORT.

SANGUISORBA. See GREAT BURNET.

SANICLE,—botanically *Sanicula*. A small genus of hardy, perennial-rooted, herbaceous plants, of the umbelliferous order. The European or wood sanicle, *S. europæa*, is an abundant weed of the groves and woods of Britain. Its root is tufted with fleshy fibres; its stem is from 12 to 24 inches high; its leaves grow for the most part from the root-crown, and are simple, deeply cloven or lobed, and of a dark shining green colour; its umbels are capitate, and form an irregular, twice-compound, umbellate panicle; and its flowers have a creamy white colour, and bloom in June and July. This plant has bitter, acrid, pungent, and somewhat aromatic properties; and it was formerly regarded as a valuable vulnerary; and it thence obtained the name of sanicle, from a Latin word signifying "to heal."

SANSEVIERA. A genus of exotic, evergreen, herbaceous plants, of the day-lily tribe,—The Ceylon species, *S. zeylanica*, was introduced to the hothouses of Britain in the former part of last century. Its root is perennial; its stem is about 2 feet high; and its flowers have a herbaceous colour, and bloom from midsummer till November. The juice of its tender shoots is given in India to young children to clear their throats of viscid phlegm. The root has a warmish taste and a not unpleasant odour, and is made into an electuary by the Indian pharmacists for the cure or alleviation of chronic coughs and pulmonary complaints. The tough stringy fibres are manufactured by the Hindoos into very valuable cordage of various sizes; and the plant is also capable of being made the material of a pretty good paper.—About a dozen other species, all of curious appearance, and most about 2 feet high, have been introduced to British hothouse collections; and a small, ornamental, Chinese species, *S. carnea*, about 6 inches high, and carrying flesh-coloured flowers from March till June, has been introduced to a place on the open flower border.

SANTALUM. See SANDAL-WOOD.

SANTOLINA. See LAVENDER COTTON.

SANVITALIA. A small genus of ornamental plants, of the sunflower-division of the composite order. The procumbent species, *S. procumbens*, is a beautiful, trailing, yellow-flowered, late-blooming, hardy annual; and was introduced to Britain about 50 years ago from Mexico; and will thrive in any common garden soil.

SAP. The liquid which ascends from the spongioles to the leaves of plants, and which contains all the principles of their nourishment, which they derive from or through the soil. See the articles ABSORPTION IN PLANTS, ASCENT OF SAP, CAMBIUM, ALBURNUM, FOOD OF PLANTS, and NUTRITION. The sap in plants is somewhat analogous to the chyme and the chyle in animals; just as the cambium which the sap goes to form performs analogous functions to the blood which the chyme and the chyle go to form; yet the analogy is very far from being complete, and must not be pushed such a length as to confound any of the broad and essential distinctions between vegetable and animal organism. See the article ANALOGY.

Sap, in so far as it has been examined, is in

some instances sweetish, in others slightly saline, and in most insipid. It is liquid and limpid and watery-looking; and consists mainly of water holding a great variety of saline and gaseous substances in solution. It combines in all proportions with water, and, when viscid or thickish, is diluted by it into a thoroughly fluid state. If exposed to strong heat, it emits bubbles of carbonic acid, and exhales a strong odour of vinegar; if submitted to distillation, it yields carbonate of ammonia; and if subjected to chemical agency, it combines readily with alkalies, and suffers thereby a neutralization of all its acid properties. But it has as yet been analysed or even closely examined in the case of but few plants; and it evidently varies widely in composition in different species, and contains principles in some which it wants in others. The sap of *Fagus sylvatica* was found by Vauquelin to contain water, gallic acid, tannin, mucous and extractive matter, acetate of potash, acetate of alumina, and acetate of lime with excess of acid. The sap of the birch and of some other trees can be manufactured into a very pleasant wine; the sap of the sugar maple is well known to yield a large proportion of the sugar used by the population of North America; and the sap of many trees, when thrown out of its course by punctures and fractures, or when enfeebled or vitiated by the want of a due proportion of azotised matter, forms most of the gums and balsams and similar vegetable exudations which are used in medicine and the arts. The sap of almost any tree or shrub may be artificially withdrawn, at any time during the rifest period of its ascent, by cutting asunder a shoot or a young branch, or by boring the stem or a main branch; and it flows chiefly from the tubes of the alburnum,—yet, in some trees, will not come from any shallower bore than one to the centre of the stem. In 24 hours, a branch of a vine has been known to yield from 12 to 16 ounces; and in the course of a season, a birch tree has been known to yield a quantity equal to its own weight, and a maple tree about 28 gallons. The several kinds of morbid and accidental diversions or outpourings of sap from its natural course are noticed in the article Extravasation.

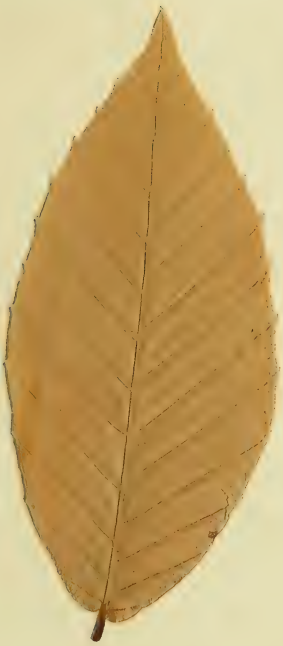
SAPINDUS. See Soap-Berry.

SAPIUM. A genus of ornamental, tropical, ever-green trees, of the spurge family. Four species, varying in natural height from 20 to 35 feet, have been introduced to Britain; and several more are known. The name sapium alludes to an unctuous fatty-looking exudation which flows from any wound in the trunk. Two of the introduced species possess properties somewhat akin to those of the poisonous manchineel. See the article Manchineel.

SAPONARIA. See Soapwort.

SAPOTA,—botanically *Achras Sapota*. An exotic, evergreen, ornamental, economical, corolliflorous tree, constituting the type of the natural order Sapoteæ. It was introduced from South America to the hothouse collections of Britain in the former part of last century. Its natural height is about 35 or 40 feet; its stem is straight, and has ash-coloured bark; its branches are produced on every side, and form a regular head; its leaves are a foot in length, and nearly 3 inches broad in the middle, and taper to a point at each end; its flowers have a cream-colour, and grow on the branches; and its fruit are large and oval or top-shaped, and have a brownish skin, or thick russet-coloured pulp, and are very luscious, and somewhat resemble the marmalade of quinces. The seeds of this plant possess somewhat aperient and diuretic properties; and the juice of it, as also that of some species nearly allied to it, is milky and constitutes a wholesome beverage or article of food. The name sapota is sometimes popularly given to the whole genus. See the article Achras.—The plants of the order Sapoteæ are either trees or shrubs, chiefly evergreen,—most of them tropical, and a few in the warmer parts of the southern temperate zone, but none natives of Europe. "The Sapoteæ," says Loudon, "are chiefly valuable for their fruit, which, in many cases, contributes richly to the dessert. Mimusops-elengi, Imbricaria malabarica, and Argania sideroxylon, are all of this description. The star-apples of the West Indies, the produce of several species of Chrysophyllum, and particularly of C. Caïnito, are esteemed delicious, and the medlars, lucumas, and sapotillas of equinoctial America, all the fruit of different kinds of Achras, are among the most valuable productions of the western world. The seeds of all the order are oily; and their oil is not fluid, but so concrete as to have the appearance and consistence of butter, whence the name of butter-tree has been applied to different species both in Africa and India. The most famous of this description is the Indian mava, mahva, or madhuca, the Bassia butyracea of botanists,—the seeds of which are so oleaginous, that a single tree has been known to produce three quintals of oil. The dried flowers of the same tree are mixed by some Indians with their food, and a kind of spirit is distilled from them by others." Upwards of 30 hothouse species, and upwards of a dozen greenhouse and hardy species have been introduced to Britain. See the articles Bassia, Star-Apple, Iron-Wood, Mimusops, Lucuma, and Bumelia.

SARACHA. A genus of ornamental exotic plants, of the nightshade family. The umbelled and the procumbent species are trailing, summer-blooming annuals, with pale yellow flowers, and with stems of 3 or 4 feet in length, and were introduced to Britain about 26 years ago from Peru. The clammy species, *L. viscosa*, is a deciduous, greenhouse, curious-looking shrub, and carries olive-coloured and white-spotted flowers in autumn, and is also an introduced plant and



a native of Peru. It takes the name "clammy" from its herbage.

SARCANTHUS. A genus of ornamental, tropical, epiphytous plants, of the orchis order. The name signifies "flesh-flower," and alludes to the texture of the sepals. A number of species have been introduced to British orchis-houses from India and China; and three of the most beautiful of these are the spotted, the bitten, and the panicled.

SARCOCAULON. A small genus of ornamental, Cape-of-Good-Hope, evergreen, undershrubs, of the geranium tribe. Two or three purple-flowered, summer-blooming species have been introduced to Britain.

SARCOCEPHALUS. See GUINEA PEACH.

SARCOCOLL. The concrete juice of the African evergreen shrub *Penœa sarcocolla.* It resembles gum arabic in both appearance and properties, but is closely allied to the saccharine matter of liquorice in chemical constitution. It is sweetish, and forms a mucilage with water.

SARRACENIA. A genus of curious, evergreen, herbaceous, North-American, thalamiflorous plants, constituting the natural order Sarraceniaceæ. Six species are known; and all are inhabitants of swamps. They differ from plants of the poppy and the water-lily orders principally in having a broad peltate leafy stigma; and they are sometimes popularly called side-saddle-flowers; but they excite the attention of the curious, and claim a place in garden collections, chiefly on account of the very singular form of their leaves. The earliest-known one may serve as a specimen of the whole; and is described as follows by Miller: —"This hath a strong fibrous root, which strikes deep into the soft earth, from which arise 5, 6, or 7 leaves, in proportion to the strength of the plant; these are about 5 inches long; they are hollow like a pitcher, narrow at their base, but swell out large at the top; their outer sides are rounded, but on their inner sides they are a little compressed, and have a broad leafy border running longitudinally the whole length of the tube; and to the rounded part of the leaf there is on the top a large appendage or ear standing erect, of a brownish colour; this surrounds the outside of the leaves about two-thirds of the top, it is eared at both ends, and waved round the border. From the centre of the root, between the leaves, arises a strong, round, naked footstalk about a foot high, sustaining one nodding flower at the top, which has a double empalement." The sarracenias cannot be very easily managed in gardens; and require frame protection, a bog soil, and constant moisture. They are propagated by division of the root.

SARSAPARILLA. A North-American, climbing, medicinal plant, of the smilax genus and order,—*Smilax sarsaparilla.* The root is perennial, and divides into straight, brown, internally white branches, 3 or 4 feet long, and rather thicker than a goose-quill; the stems are long, slender, shrubby, and spinous; the leaves are alternate, petiolate, ovate, and pointed, and have long tendrils at the base; the flowers grow in groups of 3 or 4 upon one peduncle, and have a herbaceous colour, and bloom in July and August; and the fruit are round three-celled berries, each containing two globular seeds. The root is the part employed in medicine; and has a mucilaginous and slightly bitter taste; and yields its virtues to either cold or hot water by maceration. It possesses demulcent properties; and is possibly of some use in scrofula, elephantiasis, and chronic rheumatisms. But its chief fame was formerly in a very different department of pharmacy, and has now in a main degree passed away. The plant was introduced to Britain in the latter part of the 17th century, and can be cultivated in a soil of sandy peat in the open ground. Three other medicinal species, closely allied to it, the long-leaved, the Chinese, and the syphilitic, have been introduced from respectively North America, China, and Trinidad. The word sarsaparilla or zarzaparilla signifies, in the Spanish language, a bushy little vine, and alludes to the native habit of the plant.

SASSAFRAS,—botanically *Laurus Sassafras.* A medicinal, hardy, deciduous, North American tree, of the laurel genus. It was introduced to Britain in the former part of the 17th century; and is frequently reared in shrubberies as an ornamental plant. Its natural height is from 20 to 50 feet; it stem is about a foot in girth, and has rough, furrowed, grey bark; its leaves are alternate, petiolate, lucid green above, and downy below, and have different shapes and sizes, some being oval, entire, and about 4 inches long, and a greater number lobed and about 6 inches long; its flowers are small, and grow in pendent panicles, and have a herbaceous colour, and bloom in May and June; and its fruit are oval deep-blue berries, each standing on a footstalk of an inch or two in length, and contained in a small red cup. The wood, the root, and the bark are medicinal; and have a fragrant odour and a sweetish aromatic taste; and owe their virtues to an essential oil, which can be separated by distillation. Sassafras is diaphoretic, stimulating, and diuretic; and is used in cases of gout, scurvy, chronic rheumatism, and cutaneous diseases.

SATIN FLOWER. See HONESTY.

SATUREJA. See SAVORY.

SATYRIUM. A genus of ornamental, tuberous-rooted, Cape-of-Good-Hope plants, of the orchis family. Seven or eight species have been introduced to British gardens; and about a dozen more are known. One of the introduced species, *S. carneum*, is peculiarly handsome, attaining a height of about 20 inches, and carrying pink flowers from June till September; and two, *S. papillosum* and *S. candidum*, have the recommendation of emitting from their flowers a fragrance similar to that of *Anthoxanthum odoratum*,

The satyriums are rather difficult of cultivation; but, in general, require greenhouse heat and a soil of sandy peat, and must be judiciously treated in accordance with their periods of growth and repose.

SAURKRAUT. A preserved preparation of cabbages, in common use and great esteem throughout a large part of Germany. The cabbages are cut into thin slices by hand or by a machine similar to a turnip slicer. A thick sprinkling of salt is shed on the bottom of a cask; a layer of cabbage, 6 inches thick, and seasoned or intersprinkled with whole pepper and juniper berries, is placed on the salt; alternations of the salt and the cabbage are continued till the cask is filled; a circular board, with a heavy weight on it, is placed on the topmost layer; and, when the mess ferments and sinks, additional alternations of salt and cabbage are put in till the vacuum is filled; and, afterwards from time to time, the old juice is poured off and a solution of salt poured in instead of it, till scum and fetor entirely cease. The saurkraut is now made, and may either be kept in store or be immediately begun to be used; and, whenever a portion of it is taken out, a sufficient quantity of brine must be left to cover all which remains, and to exclude the air; and the cask must ever be kept as closely as possible covered with a cloth and with the circular board and the weight. Saurkraut, when washed in fresh water, and stewed with bacon or with salted meat, is much relished by persons who have used it from their youth, and acts as a preventive of sea-scurvy in long voyages.

SAUROGLOSSUM. See Lizard's Tongue.

SAURURUS. See Lizard's Tail.

SAUSSUREA. A genus of hardy, perennial-rooted, herbaceous plants, of the thistle division of the composite order. The alpine saussurea or alpine saw-wort, *S. alpina*—called by Linnæus *Serratula alpina*—is an inhabitant of the fissures of rocks on the mountains of Britain. Its stem is from 3 to 12 inches high; its leaves are simple, distantly toothed, and cottony and very white on the under surface,—and the lower ones stand on longish channelled footstalks; and its flowers are few, and grow in a corymbose tuft, and have pink florets and blue anthers, and bloom in July and August, and make a very beautiful appearance. Ten species, chiefly with purple or red flowers, and all more or less ornamental, have been introduced from Caucasus, Siberia, and Continental Europe.

SAVINE,—botanically *Juniperus Sabina*. A medicinal and ornamental, hardy, evergreen shrub, of the juniper genus. It is a native of the South of Europe and of the Levant, and was introduced to Britain about the middle of the 16th century. Its ordinary height is 3 or 4 feet; its bark is brown; its leaves are numerous, and completely clothed with foliage; its leaves are opposite, pointed, firm, erect, and very small, and lie over one another, and give the whole plant a very lively appearance; the male catkins consist each of three times three flowers in rows, and of a tenth flower at the end; and the fruit are blackish-purple, fleshy, tuberculated, berry-like cones, each containing three small hard seeds. The leaves and tops are the parts used in medicine; and have a hot, bitter, acrid taste, and a strong, heavy, unpleasant odour; and owe their virtues to an essential oil, which can be separated by distillation. Savine is anthelmintic, emmenagogic, diaphoretic, and powerfully stimulating; and is used, in the form of ointment or of lotion, for scabies and gangrenous sores,—in the form of externally applied dried powder, for warts, carious bones, and flabby ulcers,—and in the form of internally administered powder, for gout and for certain diseases of the uterine system,—but requires to be used in the last of these ways, with great skill and caution.

SAVORY,—botanically *Satureja*. A diversified genus of plants, of the labiate order. About 15 species have been introduced to Britain from the islands and sea-boards of the Mediterranean, from the western African islands, from Carniola, and from Jamaica; and some of these are culinary, some ornamental, and some uninteresting,—one is an annual, some are herbaceous evergreens, and most are evergreen undershrubs. We need particularly notice only the two most common culinary species.

The summer or garden savory, *Satureja hortensis*, is a native of Italy and of the south of France, and was introduced to Britain about the middle of the 17th century. It is an annual, and rises with slender erect stems about a foot high, sending out branches at each joint by pairs, garnished with leaves placed by pairs, about an inch long, and one eighth of an inch broad,—stiff, a little hairy, and emitting an aromatic odour when rubbed. The flowers grow from the wings of the leaves toward the upper part of the branches, each footstalk sustaining two; the upper lip is erect and indented at the point, and the lower is divided into 3 almost equal parts; the flowers have a pale flesh colour, and bloom in July; and the seeds ripen in autumn. This plant possesses aromatic properties, and is used in the kitchen for flavouring. It may be raised from seeds sown in March, either in drills 6 or 9 inches apart, or broadcast, raked in and either thinned out to distances of 9 inches, or transplanted in June.

The winter or mountain savory, *Satureja montana*, is a native of the same countries as the summer savory, and was introduced to Britain about the middle of the 16th century. Its root is perennial; its stem is low, branching, and shrubby; its branches are ligneous, and rise about a foot high, and are garnished at each joint, with two very narrow leaves about an inch long, and send out from their base a few small leaves in clusters; and its flowers grow on short footstalks from the wings of the leaves, and are

larger and paler than those of the summer savory, and bloom in June and July. This plant is used for the same purposes as the summer savory, and has also some small medicinal reputation as an aromatic. It thrives best on poor dry soil, and may be propagated from slips or cuttings, planted in April or June, on a shady border, and the young plants must be transplanted to distances of 12 inches, and the grown plants kept bushy by cutting. One planting will serve for several years.

SAVOY, or SAVOY-CABBAGE,—botanically *Brassica Oleracea Bullata Major*. A well-known variety of the common cabbage. See the article CABBAGE. It is distinguished from the common bolling cabbages, or the varieties of *B. o. capitata*, principally by the puckering of its leaves. It is one of the prime winter vegetables, and well merits the attention of every person who has a kitchen garden, whether large or small. It comprises three subvarieties,—the large yellow, the green, and the smaller green; and the last of these is the hardiest.

The savoy must be sown early in spring, and treated similarly in the seed-bed to other spring-sown cabbages. In England, the transplanting of it, for the main winter supply, is commonly done at two or three periods in July; but in Scotland, this work should be commenced at an earlier period, and completed by the middle of that month. The soil for savoys should be rich in quality and rather light in texture, and ought to be well digged and pulverized. "Draw drills or shallow trenches about 30 inches apart; tread along the drills or press them with a broad pole, till the soil become smooth and compact; then plant the savoys 18 inches asunder, filling the holes with water and fixing the roots firmly in the soil. After they have become established, and begun to grow, the spaces will require the hoeings and diggings which are so essential to the progress of plants of all the cabbage family. As winter approaches, the earth ought to be brought up to and about the stems. If the planting be done in open, manured trenches, in dry weather, it will not only secure the growth of the plants, but greatly tend to protect them from frosts during winter. Savoys are not considered to be in perfection, till they have been exposed to a degree of frost; but they will ever after be fit for the table throughout the winter months."

SAW-DUST. Any kind of saw-dust may be very profitably converted to manuring purposes, either by using it for litter, and setting it up to ferment in mixture with about an equal quantity of common farm-yard manure, or by making a compost of it with about one-tenth of its bulk of lime, and with additions of road-scrapings and any similar substances, and allowing the compost heap to stand about three years before being used. Both of these preparations of saw-dust have been found, by actual trial, to be very good manure for turnips; and wherever saw-dust is employed in composts in any greater preponderance than we have indicated, or even in the mere degree which we have indicated, it might probably receive powerful aid from a top-dressing of nitrate of soda. A coating or thick sprinkling of fresh oak saw-dust on gravel walks, effectually prevents the growth of weeds.

SAW-FLIES. A large and mischievous family of hymenopterous insects. It possesses a deep interest to foresters, gardeners, and farmers, on account of the ravages which its larvæ make upon their crops,—particularly upon amentaceous trees, the most common fruit shrubs, and all sorts of turnips. The type of the family is the genus Tenthredo; and the scientific name of the whole, is therefore Tenthredinetæ.

The saw-flies are easily recognised by the continuousness of their abdomen with their thorax,—by the ragged appearance of their wings,—by two little rounded, granular, and usually coloured bodies situated behind the scutellum,—and by their sluggish disposition and heavy port. Their abdomen is cylindrical throughout its length, and rounded posteriorly, and comprises nine annuli, and is so closely and completely joined to the thorax as to look to be continuous with it; their antennæ differ, as to both form and composition, in different species; their mandibles are elongated, compressed, strong, and dentated; their palpi comprise six joints, and are filiform or nearly setaceous; their ligula is straight, rounded, and divided into three double portions, the intermediate of which is the narrowest; their wings are always divided into numerous cells; and their ovipositor, or egg-depositing instrument possessed by the females, is double, moveable, squamous, serrated, and pointed, and lies within a case or sheath of two concave laminæ, and is the particular object referred to in the name saw-flies. "This instrument has been variously described by authors, according to the view they have respectively taken of it, and the different species in which they happened to examine it; but it consists essentially of two pieces moving upon each other, which are smooth on their internal sides, but serrated externally with sharp oblique striæ and elevated lines; these parts being strengthened and supported by a kind of sheath composed of several pieces. When this instrument is made to act on the surface of a leaf, or a tender shoot, the lateral teeth act as a saw, while the ridges at the same time perform the office of a file or rasp. Some of the flies make a simple series of slits, others two series close together, a single egg being placed in each. Sometimes the incisions are made along the outer edge of a leaf, at others along the longitudinal ribs, and in some instances, the eggs are merely attached by a gummy substance to the surface. Not only does the saw make the necessary openings, but it irritates the wound to such a degree as to cause an overflowing of the sap; and this sap, in certain instances, is im-

bibed in some unknown manner through the membranous skin of the egg, which in this anomalous way is nourished and enlarged. In other instances the extravasated juices produce galls, which afford at once food and lodging to the young larvæ."

The larvæ of saw-flies are often called false caterpillars or pseudo-caterpillars, in consequence of their possessing a general resemblance to the larvæ of moths and butterflies, in at once the form of their body, its colours, the exterior dispositions of its dermis, and the great number of their feet; and they are the more liable to be mistaken for true caterpillars, that the two classes of depredators are often at work together in ravaging the same plant. The segments of their body generally amount to twelve; but the incisures are indistinct, and are liable to be confounded with the transverse wrinkles which abound upon the whole surface. Most of the larvæ have only one colour; yet many are marked with bright and varied colours; and so great a change of colour often takes place at moulting, an old colour being succeeded by a totally different one, that it is impossible for a general observer to recognise the same individual. Such species, too, as are furnished with tubercles or spines in the earlier stages of their larva existence, lose them at their last moult, and become smooth. All the larvæ, like the saw-flies themselves, are sluggish and comparatively inactive, seldom moving from the places of their original or periodical fixture, except when they require a new source or additional supply of food. Some lodge in the interior of fruits, and cause them speedily to decay; and some live in the interior of tender shoots, and feed on the immature pith; but the greater number live exposed on the foliage of plants,—and when not engaged in feeding, or when apprehensive of danger, most of them roll themselves into a circle, sometimes with the tail elevated in the centre. "It is of great importance to be able to distinguish the larvæ of saw-flies from the caterpillars of moths and butterflies, as the preventive or remedial treatment required for the one is often very different from what it might be desirable to adopt in regard to the other; and this distinction is easily made. True caterpillars, that is, the larvæ of butterflies and moths, have never more than 16 feet; while the larvæ of saw-flies, or false caterpillars, have generally from 18 to 22; a few have only 6, a circumstance which again distinguishes them from true caterpillars, in which the number of these parts is never below 10. Another mark of distinction is afforded by the structure of the abdominal feet. The pectoral ones are always nearly alike in both. In lepidopterous larvæ, the former are surmounted by a cornet of small hooks, which are never found in those of false caterpillars, as their abdominal legs are simple membranous protuberances. This difference of structure occasions a difference in habit, which may often enable us to determine at first sight to which of the two orders in question a caterpillar belongs, when it is seen even at a distance feeding on a leaf. The true caterpillar clings to the leaf by its abdominal legs, while the head is left free, and often borne elevated, the pectoral legs being used merely as points of support. In false caterpillars, exactly the reverse of this takes place. The pectoral legs embrace the leaf, so that the head is kept close to it; while the abdomen, unprovided with prehensory appendages, is left quite free, and is generally borne upwards, and not unfrequently twisted into various singular postures, sometimes curved inwards, at other times arched, and occasionally assuming the form of the letter S."

The pine saw-fly, called *Lophyrus* by Latreille, comprises three known British species, which sometimes work serious havoc upon pine and fir plantations. The antennæ of all the species comprise about 22 joints in the male, and from 16 to 18 in the female, and are bipectinated in the former and simply serrated internally in the latter; the mandibles are strong,—the one unidentate, and the other tridentate near the top; the maxillary palpæ are long and six-jointed; and the ocelli are three, and placed nearly in a straight line. The larvæ of all the three species—severally called *L. pini*, *L. rufus*, and *L. pallidus*—prey on the Scotch pine; but, like all others of the family, they considerably change their appearance and their colours at successive periods of their growth, and may, for all practical purposes, be recognised far more readily by their habits and their general structure than by their specific characters. "These caterpillars," says Mr. Duncan, in reference to those of *L. pini*, "attain a large size when compared with the perfect insect. Their voracity is very great; they seem, in fact, to eat with scarcely any intermission. They assemble in family parties consisting of from 50 to upwards of 100 individuals, and appear to take pleasure in carrying on all their operations in company. They place themselves along the leaves, and commencing at the top eat downwards to the sheath; very young larvæ leave the midrib standing. When the branch is suddenly struck, or they are otherwise disturbed, they quickly raise the head and anterior part of the body, and emit a drop of fluid from the mouth; and it is curious to observe a large number doing this simultaneously, and many times in succession, if the annoyance be repeated. The fluid discharged has nearly the same smell and consistency as the resinous juice of the trees on which they feed. The moultings take place exactly in the same way as in other caterpillars, and the exuviæ are observed in great quantities adhering to the branches which they have passed over." "Many of these caterpillars," he continues, in reference to those of all the three species, "fall a sacrifice to the attacks of ichneu-

mons; and when the caterpillars are young, or immediately after changing their skin, they are destroyed in great numbers by continued cold and wet weather, or hoar frost during the night. Among their other natural enemies may also be mentioned insectivorous birds, particularly the tribe of woodpeckers, which, however, are too scarce in our Scottish woods to be of much service. Mice and squirrels feed upon the pupæ, and in some cases have been known to destroy great numbers of them. After having been made acquainted with the appearance of the flies, boys might be employed with much advantage to catch them when they first begin to appear, using for this purpose a small bag-net made of gauze. The flies are at no time very active, and when employed in oviposition, they are so engrossed with their occupation, that they may be approached and secured without much difficulty. When the caterpillars abound on a branch, many of them may be brought to the ground by suddenly shaking it, or, what would be still more effectual, striking it smartly with a pole; they can then be destroyed by trampling upon them, or if a large sheet be previously spread beneath the tree, collected and otherwise disposed of. The best time for doing this is early in the morning after a cold night, as the caterpillars are then somewhat stiff and inactive, and therefore much more easily displaced. When they have prevailed for a time, and numbers have disappeared, it may be presumed that they have entered upon the pupa state; and if the moss and withered foliage be collected from the stems and roots of the trees and burnt, many will thus be destroyed. It is important also to examine the crevices of the bark, where many take up their abode; and Kollar recommends that the stem should be covered with sand a foot and a half high, and as broad, on the ground; as the larvæ and pupæ thus will not easily escape from the chinks, particularly in old trunks, where the bark is very hard, but must be stifled in the sand, and those saw-flies that are developed cannot make their way out of the sand into the open air."

The pear-tree saw-fly, *Selandria æthiops*, called by Linnæus *Tenthredo cerasi*, produces the well-known slimy grub of the pear-tree and the fruit trees. The fly is about 2½ lines long; and has short nine-jointed antennæ, with simple terminal joints,—a short, broad, black, and shining body,—and thin and somewhat hyaline wings with black nervures, and with two marginal and four submarginal cells. The larva is always covered with a kind of viscid slime; and has a dark greenish black colour; and often inflates its body and varies its shape; and resembles frequently a small snail, and sometimes a tadpole. It is an almost annual assailant of the foliage of orchards, and so riddles and skeletonizes the leaves which it attacks as to make them appear at a little distance as if they had been scorched by lightning. It makes repeated moultings among the foliage, and leaves its exuviæ in a collapsed and contracted state resembling a black thread. Some of the methods used for destroying caterpillars may be advantageously employed against it; and a sprinkling of quicklime, also, would adhere closely to its slime, and perhaps ultimately kill the larvæ.

The saw-flies of the genus *Nematus* comprise nearly forty British species, and attack a wide variety of our useful plants. Their antennæ are nine-jointed, and have the first and the second joints short and the third rather longish; their ocelli are three, and form a small triangle on the crown of the head; their mandibles are strong and acute, and usually have a single tooth on the inner edge; their wings have one marginal and four submarginal cells; and all the joints of their tarsi are of nearly equal thickness throughout their whole length. The larva of one species feeds upon the poplar; that of another lives in society on the willow; and that of another commits extensive ravages upon osier plantations. But by far the most destructive is the larva of *Nematus grossulariæ*, which feeds on the gooseberry plant, and whose habits and treatment may be regarded as sufficiently illustrating those of all the rest. The fly of this species or gooseberry saw-fly is from 4 to 5 lines long; its head is black; the organs of its mouth are more or less yellowish; its antennæ are black above and pale yellow below; its thorax is yellow, but with the disk more or less marked with black; its abdomen and its legs are yellow; and its tarsi, and sometimes the tips of the two posterior tibiæ, are black. The eggs are deposited on the under-surface of the leaves of the gooseberry plant in necklace-like rows along the principal nervures; and, in fine weather, are hatched in 7 or 8 days. The larva, when full-grown, is about three-fourths of an inch long; but usually appears less in consequence of carrying its tail curved inwards. Its head is black; its body is glaucous or bluish-green, mingled with yellow; and each segment is marked with several transverse rows of black shining piliferous warts. It makes several moultings, leaves its exuviæ on the leaves or twigs, and continues altogether as a larva during from 14 to 17 days. The pupa is longer in arriving at maturity than the larva; and, when it comes into existence late in the season, it continues throughout the winter. Two generations of larvæ almost always occur in the year,—the one in the beginning of summer, and the other toward its close; and often occasional and comparatively small broods also appear throughout the intervening period. The larvæ live in associations of from about 50 to upwards of 1,000 upon a bush; and they consume all the soft portions of the foliage, leaving only the footstalks and the principal ribs of the leaves. Various methods of destroying the larvæ or of preventing their appearance have been recommended. Attacks upon

the fly itself are of trivial efficiency; the leaves which have rows of eggs upon them may be advantageously hand-picked; and all attacks upon the larvæ themselves ought to be made as soon as possible after they appear. Gentle blows may be given to the bush to shake them down; quicklime may be cautiously sprinkled in sufficient quantity to make them drop; a wash of lime-water may be applied cold; a liquid preparation or decotion of soft soap and a little tobacco may be squirted on lukewarm; or hot water, of the temperature of from 120° to 140° Fahrenheit, may be forcibly thrown with a watering-pot or a forcing-pump. If attempts be postponed till the period of the pupa-state of the insect, they must be directed entirely to the soil around the infested bushes; and may consist in a drenching with cattle urine, or in a thick coating of seawrack, or in the depositing of a layer of unslaked lime about an inch or so beneath the surface, in such a way that all the heat evolved during the process of natural slaking will be confined within the region occupied by the pupæ.

The turnip saw-fly, *Athalia spinarum*, belongs to a genus which comprises 5 or 6 other British species, and requires to be rather minutely known in order to be distinguishable from these. The genus *Athalia* has short and somewhat club-shaped antennæ, nine or ten jointed in the male, apparently eleven-jointed in the female, the third one as long or longer than any other two,—long six-jointed maxillary palpi, the radical joint shortest,—four-jointed labial palpi, the joints nearly of equal length,—thick-based mandibles, terminating in a curved claw with a tooth,—two-lobed maxillæ, with the one lobe ovate-ended, and the other long and pointed,—and superior wings with two marginal and four submarginal cells. The species *Athalia spinarum* is from 3 to 3½ lines long, exclusive of the antennæ; and has been described as follows:—"Head wider than long, deep black, with three ocelli in the centre; eyes oval; antennæ black above, and for the most part dull yellow beneath; labrum and palpi light yellow; thorax black above, with a triangular space in front, the scutellum and a spot behind it reddish-orange; the collar, which is rather long and slender, black on the sides and yellow in the middle; abdomen rather short, entirely orange-yellow, inclining to red, with a small black spot on each side of the first segment; legs likewise orange-yellow, the tarsi paler, approaching to whitish, the tip of the tibiæ and of each of the tarsal joints black; the tibiæ with two spines at the apex, and the joints of the tarsus each with a very slender lobe beneath; extremity of the ovipositor black; wings yellowish at the base, the costa and stigma black." But several slight varieties occur; and in particular, the thorax is sometimes entirely black, and the scutellum is often of the same colour. The eggs are deposited on the young turnip-plants, for the most part round the outer margin of the leaf, in the early part of summer; and, if the weather be favourable, are very soon hatched. The larvæ are at first small, but grow rapidly, and in the course of a few weeks attain their full size. They have at first a deep black colour; but, after their last moult, they have a dark lead or slate grey colour. They are known by a number of popular names, which allude to either their colour or their ravages, such as blacks, black caterpillar, nigger, canker, &c. They attack the turnip-plants as soon as they are hatched, and eat voraciously, and sometimes destroy the whole crop, and seldom do less injury than to occasion dwarfishness in a large proportion of the bulbs; and, when they are touched, or in any way disturbed, they coil themselves up, and remain motionless; and, when full grown, they cease to eat, and either bury themselves in the soil or take refuge among moss, rotten leaves, or other rubbish, there to undergo their transformation into pupæ. The havoc done by these devastators in 1835 and some subsequent years was so great as materially to affect the interests of British agriculture; and the rapidity of it was sometimes such as to astonish and bewilder farmers, who were not acquainted with the saw-fly's habits. A distinct warning is given to ordinarily observant cultivators by the appearance of the flies themselves about a fortnight before the ravages of the larvæ can commence; and the sad retribution awaits any farm where the larvæ appear and are not destructively dealt with, that, after passing into the pupæ state, they give origin in about 20 days, to a fresh race of flies, whose larvæ will destroy a re-sown or second turnip crop. Yet though many preventive and remedial means have been tried, really effective ones are either not uniform or comparatively critical, dear, or difficult.

The destruction of the turnip saw-flies themselves is a prime remedy, in so much that the killing of every individual fly is the prevention of an entire colony or succession of colonies of larvæ. The flies are so sluggish and inactive, and so seldom fly speedily or to a distance, that they can easily be caught by means of a small bag-net or even by the hand. A distinguished farmer in Yorkshire states, in the Highland Society's Transactions, that he always instructs his turnip-hoers to leave their work and chase and destroy every saw-fly they see, and that, simply in consequence, as he believes, of this one precaution, his turnip-fields have escaped injury while others in the same parish were more or less consumed. Swallows eat the flies, and sometimes skim over the fields in search of them, and then do valuable service; and rooks also make such sweeping attacks upon the caterpillars, that they have been known to act as complete conservators of a turnip crop in the vicinity of a rookery. Applications of wood-ashes, coal-ashes, quicklime, unslaked lime, soot, saline mixtures, saline solutions, preparations of arsenic, and other sub-

stances have been made by way of sprinkling or aspersion on the crops after the larvæ appeared; but they have been only sometimes or limitedly effectual,—and have, at other times, been either quite useless or positively hurtful. A copious aspersion with sea-water, or a dusting of finely powdered salt at a time when the plants are wet with rain or with heavy dew, is probably the best, as it is the simplest, of these applications. The mere negative remedy of not hoeing or not thinning when the larvæ appear is highly beneficial; for if the crop be allowed to continue thick till the larvæ period cease, more food may be present than the larvæ can consume, and only the sound or the least injured plants may be allowed to stand at the subsequent thinning,—and if the soil be comparatively skinned and hard when the larvæ fall, it will resist their efforts to burrow in it for transformation, and may cause them to perish on the surface. Drawing a cart-rope over the crop to shake off the larvæ is sometimes very effective, but cannot always be depended on. The brushing of the drills with live twigs, either vibratingly twice or thrice a-day during the whole larvæ period so as to dislodge the larvæ from their feeding-hold of the plants, or switchingly a single time or two times so as to sweep the larvæ aside into the spaces between the drills, has also been found effectual; and in the latter case, the persons brushing must crush the larvæ with their feet as they pass on, and a man must closely follow with a scuffler to cover the whole spaces between the drills. By far the best method, however, is either hand-picking or the use of poultry, particularly young ducks. "Hand-picking, it is true, is tedious, if not expensive, where the caterpillars are so numerous that as many as 16 score have been counted on one large plant; but in such cases they should be brushed or whipped off into fruit-baskets or sieves; otherwise pint or smaller pots are well adapted for collecting them, which can be emptied into large covered vessels at the head of the field, containing some salt and water, or lime-water, to prevent the caterpillars from crawling out." Even in fields where the larvæ are by no means abundant, five or six children, of from 6 to 10 years of age, gathering only 8 hours a-day, will collect in a week about 45,000 or 50,000. As to poultry, they make sure and clean work; and young ducks, especially, have been tried with universal success, and are now the general favourites,—and they possess at the same time the useful propensity of eating up slugs and other small mischief-working animals. Even when a field has, to some extent, been all but destroyed, the introduction of ducks has speedily changed its appearance. Yet the larvæ ought never to be allowed to make any progress in devastation; and the farmer should be on the watch for them the instant they are hatched, and immediately set his ducks and poultry to do their duty. "Nearly 400 ducks were at work at one time, on two farms in Norfolk, and saved all the crops entrusted to their care. When such large numbers are employed, they ought to be formed into detachments of not more than 100, and each must be attended by a boy or girl, to precede them with a long light pole or willow rod, to brush the caterpillars off the leaves, as well as to drive the birds to water and to rest 3 or 4 times a-day. After drinking, the ducks will often disgorge the caterpillars in great quantities, and soon go to work again with whetted appetites. They must also be driven home at night, and put into a barn, where they ought to be fed with a little barley or other grain to keep them in health and vigour, otherwise so much living animal food disagrees with them, and causes purging. Old ducks do not work well, and are liable to attack the turnip-tops, and do as much harm as good; so that only young ducks should be selected of from 3 to 5 weeks old. Mr. Sells recommends that, after ducks and fowls had been made to fast a few hours, they should be tried with the larvæ, either alone or mixed with barley, by which means they would become acquainted with the insect to be sought for, and probably take a predilection for it."

The corn saw-fly, *Cephus pygmæus*, belongs not properly to the tribe Tenthredinetæ, but forms a connecting link between it and the nearly allied tribe Siricidæ; and it is commonly assigned to the latter tribe, and was called by Linnæus *Sirex pygmæus*. It abounds in Britain, and sometimes inflicts material injury upon wheat and rye crops; and yet it has hitherto been exceedingly little noticed in connexion with agricultural science. The fly has a shining black colour; the head is rather large, and has prominent eyes, and three minute ocelli on the crown; the antennæ have 21 joints, and are tolerably long and slender, but slightly clavate; the thorax is oval and not broader than the head; the abdomen is rather long, slender, and slightly compressed, but has more of the two first of these characters in the male than in the female; and the four wings are transparent and iridescent,—the superior ones with two marginal and four submarginal cells, the costa and stigma yellowish-brown, and all the nervures brown and slender. The larva is 6 lines long, a little thickened anteriorly, nearly cylindrical, of a yellowish milky white colour, tolerably fleshy, and more like a large maggot than a caterpillar; its head is rounded, corneous, and ferruginous, and has minute four-jointed antennæ; its three thoracic segments have each two nipples beneath in place of feet; and its last segment is terminated by a small tubular appendage, which is protrudible like a telescope, and assists the animal in its progress within the interior of a culm. The pupa is enclosed in a transparent cylindrical cocoon, about 5 lines long, rounded at the one end, and irregularly stopped up at the other.

The corn saw-fly may be seen every year in

June on flowers in corn-fields, and on grass in woods; and the larvæ may be found after harvest, and even during winter, ensconced in the stumps or roots of stubble. The flies of a season issue from the cocoons toward the end of May; the females, after the pairing-time, pierce the culms of growing rye or wheat below the first joint, and deposit their eggs in the interior; the eggs are soon hatched within the protection and concentrated heat of their snug position; the young larvæ live on the tender cellular matter of the culms, and on the nutritive juices of the sap, which ought to form the grains in the ear; and, when they become older, they penetrate through the knots to feed in the higher divisions of the culms; and, when they attain full size, they descend to the base, and cut down the straw nearly level with the ground, and descend into the stump a little below the soil, there to remain ensconced for eight months, and to undergo their transformations towards the next year's race of flies. The plants infested with the larvæ never acquire a tolerably full ear of grain,—and become erect and whitened at the top while their healthy neighbours are still green and nodding,—and are liable to be broken off at the foot and thrown completely over by the first considerable wind which blows after they are sawed,—and, when they are pretty numerous and in lines, they make blank and unproductive tracts in a crop of the same appearance as if the field had been traversed in every direction by sportsmen or by quadrupeds. The best means hitherto suggested for preventing these devastations, in any field where the larvæ are known to exist, is either to set fire to the stubble after harvest, or to plough it completely over in March or the beginning of April.

SAW-WORT, botanically *Serratula*. A genus of ornamental herbaceous plants, of the thistle division of the composite order. The name alludes to the sawed form of the leaves. One species grows wild in Britain; about 30—all hardy and chiefly perennial-rooted and purple-flowered —have been introduced to Britain from other countries; and about 10 or 12 more are known.

The common or dyeing saw-wort, *Serratula tinctoria*, inhabits the groves, woods, thickets, and grassy pastures of Britain. Its root is perennial and woody; its stems are annual, erect, straight, solid, angular, striated, reddish, and about 3 feet high; its leaves are pinnatifid, and somewhat lyrate, and have abundant, fine, bristly serratures; its flowers are corymbose, and of a purplish crimson colour, and bloom from July till October; and its seeds have a bristly, yellowish, unequal coronal. This herb gives a yellow colour to wool; and is much used for that purpose in Sweden; and possesses, in some places, the rank of a cultivated plant.

SAXIFRAGE, — botanically *Saxifraga*. A large genus of calyciflorous, ornamental, herbaceous plants, constituting the type of the natural order Saxifrageæ. The plants of this order are principally low-growing herbs, inhabiting mountains, rocky grounds, dry walls, the sides of springs, and peculiar marshy situations, either in the cold regions of the world or in the alpine portions of the hot ones; and they form the most attractive and beautiful of all the groups of alpine flora. They do not possess either grandeur or brilliance or showiness; but as a group, they are eminently distinguished for neatness and perpetuity of low-growing foliage, and for exquisite simplicity and meek, sweet, blushing beauty of blossom. One genus, indeed, is shrubby and quite unlike the rest; but the other genera afford an absolute profusion of the loveliest of the class of ornamental plants which are fittest for clothing rock-work and for decorating the slopes and breaks of naked banks. Five or six greenhouse species, 6 or 7 hardy ligneous species, and nearly 150 hardy herbaceous species occur at present in the wilds and gardens of Britain; and are distributed among 10 genera, —by far the most important of which is Saxifraga itself. A few of the species possess astringent properties; and one, *Heuchera americana*, is said to be lithontriptic and anticancerous.

The saxifrage genus consists chiefly of low, hardy, evergreen herbs, and is, in a sense, somewhat simple and uniform; and yet it has occasioned great perplexity to botanists, and comprises a remarkably rich and almost startling diversity in the aggregate appearance of its plants, and especially in the characters of their foliage. Thirty-two species of it grow wild in Great Britain and Ireland; about 70 species have been introduced from other countries; and about 40 more species are known. The foliage of the genus varies from a cabbagy appearance to a mossy one, and from a smooth to a hairy or a glutinous, and from neat or ordinary to intricate or grotesque; its flower-stalks vary in height from one or two to about 30 inches, and are in some instances slender and naked, in others stout and leafy; its inflorescence is in a few cases solitary, and in the rest either panicled or corymbose; and its flowers are either white, or yellow, or flesh-coloured, or purple, or of some kindred tint, and are often spotted and always meekly and gently beautiful. Most of the species thrive excellently in sandy loam or in any common garden soil; and all the perennials may be readily propagated by radical division, and the few annual ones from seed.

The shady saxifrage, or London pride, or none-so-pretty, *S. umbrosa*, is the best known of all the species, whether indigenous or exotic, and may be advantageously selected as a specimen of the whole. It grows wild on some mountains of Britain; and abounds on the mountains of the south-west and north-west of Ireland; and has a place in the little flower-plots of the humblest cottages; and may sometimes be seen as an ornamental edging-plant in the most aristocratic and

gorgeous flower-gardens. It is an evergreen, and blooms from April till June. "The roots are perennial. The leaves are oblong, oval, and placed circularly at bottom; they have broad, flat, furrowed footstalks near 2 inches long; they are deeply crenated on their edges, which are white. The stalk rises about a foot high, is of a purple colour, stiff, slender, and hairy; it sends out from the side on the upper part several short footstalks terminated by white flowers spotted with red. The stamina are longer than the petals of the flower, as are also the two styles,—and these have red stigmas."

The following species grow wild in both England and Scotland,—The intermediate, *S. media*, on mountains, purple-flowered, a foot high, and blooming from April till June; the toothed, *S. dentata*, on mountains, white-flowered, a foot high, and blooming in May and June; the starry, *S. stellaris*, on the banks of mountain rivulets, white-flowered, 3 or 4 inches high, and blooming in June and July; the grain-rooted, *S. granulata*, on meadows and pastures, white-flowered, a foot high, and blooming in May; the aizoon-like, *S. aizoides*, on the banks of mountain rivulets, yellow-flowered, 5 or 6 inches high, and blooming in July and August; the autumnal, *S. autumnalis*, similar in height and colour of flower and time of blooming to the preceding; the opposite-leaved, *S. oppositifolia*, on mountainous rocky ground, purple-flowered, 1 or 2 inches high, and blooming in March and April; the five-cleft, *S. quinquefida*, on mountains, white-flowered, 6 inches high, and blooming in May and June; the three-fingered, *S. tridactylites*, on walls, white-flowered, 3 or 4 inches high, and blooming in April and May; and the moss-like, *S. hypnoides*, on dry rocks, white-flowered, 3 or 4 inches high, and blooming from April till June. All these species are fibrous-rooted evergreen herbs, except the three-fingered and the grain-rooted, the former of which is an annual, and the latter a tuberous-rooted perennial.

The following species grow wild in England or Wales, but not in Scotland,—The hirculus saxifrage, *S. hirculus*, in turf-bogs, yellow-flowered, 6 inches high, and blooming in August; the deceptive, *S. decipiens*, in moist places, white-flowered, 3 or 4 inches high, and blooming in May and June; the fine-leaved, *S. leptophylla*, on the Welsh mountains, white-flowered, 6 inches high, and blooming in May and June; and the turfy, *S. cæspitosa*, on very lofty Welsh mountains, crimson-flowered, 3 or 4 inches high, and blooming in May and June. The first of these four species is an annual-stemmed perennial, and the other three are fibrous-rooted herbaceous evergreens.

The following grow wild in Scotland, but not in England or in Wales,—The snowy, *S. nivalis*, on lofty Highland mountains, white-flowered, 3 or 4 inches high, and blooming in June and July; the dissimilar, *S. dissimilis*, on the banks of the rivulets of Ben-Nevis, white-flowered, 5 or 6 inches high, and blooming in June and July; the drooping, *S. cernua*, on lofty Highland mountains, white-flowered, 3 or 4 inches high, and blooming in July; the brook, *S. rivularis*, on Highland mountains, white-flowered, 1 or 2 inches high, and blooming in June and July; the pedatifid, *S. pedatifida*, on Highland mountains, white-flowered, 6 inches high, and blooming in May and June; the dwarfish or the musky, *S. pygmæa*, on Highland mountains, white and yellow flowered, 1 or 2 inches high, and blooming in May and June; the stripped, *S. denudata*, on lofty ground, white-flowered, 3 or 4 inches high, and blooming in May and June; the broad-petaled, *S. platypetala*, on rocky mountainous ground, white-flowered, a foot high, and blooming in June; the hairy, *S. hirta*, on lofty Highland mountains, white-flowered, a foot high, and blooming in June; the longish-stalked, *S. elongella*, on Highland mountains, white-flowered, a foot high, and blooming in April and May; the lively-green, *S. lætevirens*, on lofty ground, white-flowered, 6 inches high, and blooming in May and June; the dense, *S. condensata*, on mountains, white-flowered, 3 or 4 inches high, and blooming in May and June; and the pretty, the mossy, the clammy, and the narrow-leaved varieties of *S. hypnoides*, on mountains, white-flowered, 6 inches high, and blooming in May and June. All these peculiarly Scotch kinds are herbaceous evergreens.

The following species grow wild in Ireland, but not in Britain,—The incurved-leaved, *S. incurvifolia*, on rocks, white-flowered, 3 or 4 inches high, and blooming in May and June; the polished, *S. polita*, on mountains, white-flowered, a foot high, and blooming in May and June; the geum, *S. geum*, on mountains, white-flowered, a foot high, and blooming in June and July; the elegant, *S. elegans*, a rare species, quite recently become known; and the hirsute, *S. hirsuta*, on mountains, flesh-colour flowered, a foot high, and blooming in May and June. All these five species are herbaceous evergreens.

SAXIFRAGE (Burnet). See Burnet Saxifrage.

SAXIFRAGE (Golden). See Golden Saxifrage.

SCAB. A loathsome and troublesome disease in sheep, analogous to itch in man and to mange in horses and cattle. See the articles Acari and Mange. It is highly contagious and exceedingly mischievous, and always gives great annoyance upon a stock-farm, and sometimes causes considerable mortality. It may originate in filth and poverty; and, when once it gets among a flock, it is rapidly propagated by actual contact, and by the sound sheep lying upon the spots and rubbing upon the posts which have been touched by the affected. It generally first reveals itself to the shepherd by the sheep becoming so itchy as to rub themselves upon posts or rocks or walls

or any other convenient objects,—a symptom which does not appear till about 12 days after the infection has been received; but it may, on examination, be detected much earlier by unnatural redness and floridness of the skin. It progresses from irritation to pustular eruption; and when the extreme itching and the rubbing begin, the skin is already rough and dotted with hard pimples; and in a few days, the pustules break, sores occupy their place, and scabs are formed; and, in the farther process of rubbing and exposure, the scabs are removed, the sores are aggravated and extended, the wool is denuded, maggots may begin to assist the horrible devastations of the acari, deep sinuses may be formed, and either incurable ulceration or total exhaustion may render speedy death inevitable.

"Although fat sheep, or those in improving condition, seem less liable to be attacked with scab than others, it is not, as some have supposed, a disorder in the blood, and to be cured by change to richer pasturage. It is strictly a cutaneous and local disease, although, like other local complaints, it will seriously and even fatally injure the constitution if not checked in its early stages. If speedily discovered, sulphur ointment will prove a remedy; but in more serious cases, in order to effect a cure, it is necessary to dress the sheep with mercurial ointment, which operation is performed according to the following directions:—Divide the wool into two parallel lines, about 2 and 4 inches from the back on both sides, and also one line down the shoulders and thighs; lay on the ointment close to the skin with your fore-finger as you make the divisions; lay another furrow or line down the throat, under the belly, and between the fore and hind legs; at the same time examine carefully for the affected parts, and dress them. Three pounds of an ointment, formed of 1 lb. of quicksilver, ½ lb. of Venice turpentine, 5½ lb. of hog's lard, and ½ lb. of resin, are sufficient for a score of large sheep, and two pounds and a half for hoggets or sheep in low condition. Highly useful as this preparation is for the cure of so troublesome a complaint, and much as it is recommended, yet there is scarcely a farmer that has used it without the loss of sheep from its injudicious application. October and March are the proper months for dressing, when the weather is dry; nor should it be delayed to a later season. In hot weather, the absorbent vessels carry it too quickly into the system, and the sheep become salivated, and also in the winter, from lying on the cold and wet ground. It is also highly dangerous to use it on ewes before or after lambing; nor is it safe at any time to anoint sheep that are poor or weak. But the following infusion will answer the purpose when it is improper to use the mercurial ointment:—Boil half a pound of tobacco in two gallons of water until reduced to one; strain and then add half a pint of spirit of turpentine, and half a pound of flowers of sulphur. On the application of this mixture, the scabs should be broken, and every affected part well searched and dressed. As this decoction, as well as the ointment, stains the wool and disfigures the sheep, immediately after they are shorn, a lotion of one ounce of corrosive sublimate, ¼ of a pint of spirit of wine, and 3 quarts of spring water may be used, first washing the animal well with soft soap and warm water. Every infected sheep should be removed from the flock as soon as dressed, and until there is a satisfactory proof of its convalescence. Even here, however, the anxiety of the farmer is not at an end. The complaint is probably more contagious than any other that can be mentioned. It has often happened, that, after all the stock has been sold and replaced, the new comers have been speedily infected. This is occasioned by coming in contact with the fences against which the diseased sheep have been in the habit of rubbing themselves; the wool left on the posts retaining some of the eggs or larvæ of the vermin, and of course communicating them to the new flock. The prudent farmer should, therefore, cause all flakes of wool remaining on the hedges to be carefully collected by his boys, and he should also remove all useless posts, and paint or tar the gates, or wash them with a solution of the chloride of lime, before he uses the same pastures again. Some complaints have been erroneously confounded with the scab, and much inconvenience and even mischief has arisen from the mistake, all the usual remedies to avoid contagion being taken unnecessarily. Hard and scurfy eruptions, and some species of the ticks, have been considered to be scab, and treated accordingly. The shepherd will be guided in his judgment by the actions of the sheep; if he observes that the painful itching and incessant rubbing are wanting, he may safely conclude that the attack is not scabby in its character. In some parts of the country, the scab in its most virulent form is known by the name of 'wildfire.' It becomes a species of erysipelas."

SCABIOUS,—botanically *Scabiosa*. A genus of ornamental plants, of the teasel family. The majority of the species which formerly constituted it, and which rendered it a large genus, are now assigned to the genera succisa, cephalaria, and pterocephalus. But one British species and nearly 20 hardy introduced species, three of them annuals, and the rest radical herbaceous perennials, still belong to it.

The indigenous species, *S. arvensis*, occurs in corn-fields and pastures, and is one of the most beautiful of our wild plants. Its root is perennial; its stem is annual and bristly and about 2 or 3 feet high; its radical leaves are stalked, lanceolate, and serrated; its cauline leaves are sessile and pinnatifid; and its flowers are large and handsome, and have a fine pale purple colour, and bloom from July till October. This herb has a bitter and nauseous flavour, and is disliked

by cattle, yet is eaten by sheep and goats. A white-flowered variety of it, *S. a. flore-albo*, occurs in gardens.

SCÆVOLA. A genus of ornamental exotic plants, of the goodenia tribe. Two evergreen herbaceous species about 20 inches high, and 6 or 7 evergreen ligneous species of from 20 to 40 inches in height—the former propagable by radical division, the latter from cuttings, and all loving a soil with some mixture of peat—have been introduced to the greenhouses and hothouses of Britain, principally from Australia and India; and nearly 20 more are known. The flowers of most are white; and those of the rest have some shade of blue or red.

SCALLION. See ONION and SHALLOT.

SCAMMONY. See BINDWEED.

SCANDIX. A genus of white-flowered, annual plants of the umbelliferous order. Venus's comb or the shepherd's needle, *Scandix pecten*, is a common troublesome weed of the corn-fields and other cultivated lands of Britain. Its root is tapering; its stems are simple but bushy, spreading, furrowed, leafy, and from 6 to 12 inches high; its leaves are light green and trebly pinnatifid; its leaflets are linear, acute, and smooth; its umbels are small, simple, solitary or in pairs, and chiefly terminal; and its fruit is nearly smooth, and has a bushy edge, and sends out a beak like a large needle to the length of one or two inches.

SCANTERING. See DIARRHŒA.

SCARCEMENT. A projecting slope from the base of an earthen fence, or from the line or level of a bank along which a hedge is planted. Scarcements were recommended by the old writers on hedging; but are now regarded, by all good judges, as serving no good purpose, and as encouraging a rank and noxious growth of weeds.

SCARIFIER. See GRUBBER.

SCARLET RUNNER. See KIDNEY BEAN.

SCHEDONORUS. A genus of grasses of the glyceria tribe. Five species are indigenous in Britain; at least a dozen species have been introduced from other countries; and about 20 more are known. The majority of the species at present in Britain are ranked by all the older botanists as fescues, and have been noticed in our article FESTUCA; and the others, even when viewed in the aggregate, do not possess much economical interest, and comprise only three which have any noticeable claim to the status of agricultural plants; and these three are, *S. deciduus*, a perennial indigen of the moist meadows of Britain, about 20 inches in height,—and *S. poæformis*, and *S. nigrescens*, both perennials of about a foot in height, introduced in 1819 from Switzerland. The name schedonorus signifies "near to a mountain," and alludes to the habitat of some of the principal species.

SCHEUCHZERIA. A curious evergreen herbaceous plant, of the order Juncagineæ. It occurs in the marshes and wet spongy bogs of some parts of England, but is very rare. It constitutes a genus of itself; and takes the specific name of *palustris*. Its root is creeping; its herbage is smooth, and has a white, shining, lax cuticle; its stem is erect, wavy, simply racemose, and 4 or 5 inches high; its leaves are few, sheathing, and cylindrical; and its flowers grow in a terminal cluster of about five, and have a brownish green colour, and bloom in May and June.

SCHINUS. A genus of ornamental exotic plants, of the terebinth tribe. The Peruvian species, or Indian mastic, *S. molle*, is an evergreen shrub of Peru and Mexico, and was introduced to the gardens of Britain toward the close of the 16th century. Its stem is from 8 to 12 feet high, and divides into many branches; its bark is dark brown; its leaves are alternate and pinnate, and have each from 10 to 15 pairs of leaflets, and a comparatively long terminating odd one; its leaflets are about $1\frac{1}{2}$ inch long and $\frac{1}{4}$ of an inch broad, and taper to the point, and are somewhat sawed on the edges, and have a lucid green colour, and emit a turpentine odour when bruised; and its flowers are very small, odourless, and of a greenish white colour, and grow in loose bunches at the end of the branches, and bloom in July and August. This plant requires a soil of rich mould, and is propagated from seeds or layers. Its leaf-stalks, when broken, and also the entire leaves of the nearly allied terebinthaceous plant, *Duvaua latifolia*, exhibit a curious and beautiful phenomenon when thrown into water,—the former producing numerous, tinted, floating, star-like figures which move about like dancers in a ball-room or like the ships of a fleet in manœuvring, and the latter starting and jumping up as if they were alive, and, at the instant of each start, discharging a jet of oily matter into the water. "This circumstance," says Dr. Lindley, "appears to be owing to some peculiar irritability of the parenchyma of the leaves, which, when acted upon by water, causes the turpentine sacs, that abound in the leaves, to empty themselves with violence; and the movements of the leaves may be ascribed to the recoil produced by the discharge. Thus we have in every leaf a sort of vegetable battery, which will keep up its fire until the stock of ammunition is expended."

SCHISMUS. A small, hardy, annual grass, of the oat tribe. It was ranked by Linnæus as a fescue; but it now constitutes a genus of itself, and is specifically called *marginatus* or the margined. It is a native of Spain, and was introduced to Britain nearly 70 years ago. It has a height of only 6 or 7 inches.

SCHIZANTHUS. A genus of ornamental, hardy, annual plants, of the figwort family. The name signifies torn-flower; and alludes to deep and numerous indentations in the borders of the corolla; and is very descriptive. Five species,—the pinnate, the spreading-stalked, Graham's, Hooker's, and the retuse-petaled—

were introduced to Britain from Chili about 20 or 24 years ago; and some other species and varieties have been obtained since that time; and all are handsome and delicate, and well deserve a place among the choicest annuals of the open garden. They have a height of from 12 to 24 inches; and carry a great profusion of flowers; and thrive best on a light loamy soil. The flowers of most are variegated in colour; and those of the several species have a predominance of either red, scarlet, lilac, rose, purple, or white.

SCHIZOPETALON. A small genus of ornamental exotic plants, of the cruciferous order. Walker's species, *S. Walkerii*, is a curious and interesting annual, and carries white flowers during about two months, and was introduced to Britain in 1822 from Chili. The name schizopetalon signifies 'torn petal,' and is descriptive.

SCHMIDELIA. A genus of tropical, ornamental, evergreen shrubs and trees, of the soapberry tribe. Four species, varying in height from 8 to 25 feet, and all white-flowered, and loving a soil of peaty loam, and propagable from cuttings, have been introduced to British collections from the East and West Indies; and upwards of a dozen more are known.

SCHMIDTIA. A small, curious, hardy, annual grass, of the agrostis tribe. It constitutes a genus of itself, and was introduced to Britain about 28 years ago from Bohemia.

SCHŒNUS. See Bog-Rush.

SCHOTIA. A genus of ornamental, crimson-flowered, Cape-of-Good-Hope, evergreen shrubs, of the cæsalpinia division of the leguminous order. Four or five species, of 5 to 6 feet in height, and mostly continuing in bloom through the greater part of summer and autumn, have been introduced to British gardens; they require a higher degree of heat than most Cape plants, and thrive best in a soil of peaty loam.

SCHUBERTIA, or Taxodium. A small genus of ligneous plants, of the coniferous order. It consists of two species which were formerly ranked as cypresses; and it differs from the cypress genus, both in habit of growth and in the arrangement of its inflorescence,—its male flowers forming long, loose, pendulous catkins, somewhat branched near their base, and its female flowers being scarcely apparent, and existing in small and almost sessile clusters.

The two-rowed schubertia, or deciduous cypress, or North American deciduous cypress, *Schubertia disticha* or *Taxodium distichum*—formerly called *Cypressus disticha*—is a native of the swamps and wet alluviums of Virginia, Florida, Louisiana, and other parts of North America, and was introduced to Britain before the middle of the 17th century. It covers vast tracts in its native regions; and gives them the popular name of Cyprieres; and sometimes attains a height of about 120 feet; and has generally a conical form of stem, with a girth 3 or 4 times greater at the base than toward the top; and has sometimes so vast a basal girth as from 20 to 40 feet. In Britain it is quite hardy; and requires a place in the moistest part of a plantation, or by the side of a rivulet, or spring, or pond; and commonly attains a height of from 30 to 60 feet. It grows conically while young; but becomes wide-spreading and often flat-topped when old. It presents some resemblance to an evergreen in summer, and has very pleasing foliage, not unlike that of some kinds of acacia, and is, therefore, well fitted to decorate certain parts of ornamental grounds. Each leaf is from 4 to 5 inches long, and has a midrib and two opposite rows of leaflets, and is of a pleasant light green colour in summer, and changes to a dull red in autumn. The leaflets are narrow, straight, fine, and slightly concave on the upper surface, and generally fall before the midribs. The full-grown cones are nearly globular and fully an inch in diameter, and have thick and woody scales, rounded at the outer extremity. The seeds are small, hard, and irregularly round; and comprise each six or seven cotyledons. The timber has a reddish colour, and is elastic, strong, and durable, and neither so heavy nor so resinous as the timber of the pines. This tree is one of the most important timber trees of North America; but is not suitable to be grown in Britain, except for ornament or in warm, sheltered, swampy nooks, upon a soil of sandy peat. It may be propagated either from seeds in the same manner as the common cypress, or from cuttings planted in a moist sandy soil in October. Five very distinct varieties of it, all propagable from seeds, occur in British collections, —the spreading, the lofty, the drooping, the Chinese, and the pendulous; and the two last of these are natives of respectively China and South America.

The Cape schubertia, or African cypress, or juniper-like cypress, *Schubertia capensis* or *Taxodium capense*—called by Linnæus *Cupressus juniperoides*—is an evergreen shrub of commonly about 6 or 7 feet in height; and was introduced to Britain, about 90 years ago, from the Cape of Good Hope. Its branches are numerous and slender, and spread themselves all around; its leaves are opposite, narrow, awl-shaped, of a light green colour, and about an inch in length; and its flowers come out from the sides of the branches, and bloom in April and May, and are succeeded by black fruit.

SCILLA. See Squill.

SCIRPUS. See Club-Rush.

SCITAMINEÆ. A natural order of monocotyledonous plants. It is nearly allied to the orchidaceous order, but differs in its pollen not cohering in masses, in its ovary being plurilocular, and in its seeds not being winged. It occurs only within the tropics, and consists almost wholly of stemless or caulescent herbs, with long broad leaves, and with white, yellow, or red flowers, most of which are beautiful, and not

a few delightfully fragrant. The roots and seeds of most of its species are more or less aromatic; and those of some—such as the roots of ginger and the seeds of cardamon—occupy a most distinguished place among the aromatics of the materia medica. Nearly 150 species, belonging to 11 or 12 genera, have been introduced to the gardens of Britain; and nearly all require hothouse culture.

SCLERANTHUS. See KNAWEL.

SCLEROCHLOA. A genus of hardy, annual grasses of the fescue tribe. The procumbent species, *S. procumbens*, is a weed of the sea-coasts of Britain, and has a height of 6 or 7 inches, and blooms in July and August; and the rigid species, *S. rigida*, is a weed of sandy grounds in Britain, and has about the same height as the preceding, and blooms in June and July. These two species are popularly called hard grass; and are assigned by some botanists to the genus poa. Four species—but none of them economically interesting—have been introduced from other countries.

SCOLOPENDRIUM. See HART'S TONGUE.

SCOLYMUS. See GOLDEN THISTLE.

SCOLYTUS. A genus of the xylophagous family of beetles. It is distinguished, along with the genera tomicus, hylurgus, and hylesinus, for its devastations upon timber. See the article BOSTRICHIDÆ. It has nine joints in the antennæ below the club, strong and obtusely triangular mandibles, short and four-jointed maxillary palpi, cylindrical body with the apex of the abdomen obliquely truncated, and four-jointed tarsi.

The destroying scolytus, *S. destructor*, has excited vast attention on account of its enormous devastations upon avenues and groves and plantations of elm. The perfect insect is black and shining, and about $2\frac{1}{2}$ lines long; its head is clothed with short yellowish hairs; its thorax is large and finely punctured; its elytra vary in colour from almost black to almost chestnut, and have each seven punctured striæ; its abdomen is hairy; and its legs and antennæ are dull red. The larva is a small, white, fleshy grub, destitute of legs, and pretty similar in appearance to the larva of the nut weevil; its head is smooth and horny, and has no antennæ; its jaws are obtuse and strong; its body is curved into a semicircle; and the segments are transversely channelled. This insect, though for 12 or 15 years past threatening many of the elm plantations of England and of the environs of the principal cities of northern continental Europe with extermination, was not known to entomologists as an elm destroyer till about the year 1824. Extensive injuries inflicted by it, in St. James' Park, Hyde Park, Greenwich Park, Camberwell Grove, and other parks and promenades around London, were ascribed to human malice or misconduct, and occasioned angry excitement and legal investigation, but eventually suggested inquiry by competent naturalists under the authority of government, and led to the full discovery of the true cause. An indiscriminate felling and uprooting of many thousands of diseased trees was resorted to for extirpating the insect, but was found to produce little or no effect; and the signal failure of so very costly and deplorable a resource urged investigators onward to the eventual discovery of a true though still costly remedy. Erosions are made by the female beetle and by the larvæ in the bark, the inner bark, and the alburnum; and whenever these become very numerous, they so greatly interrupt the ascent of the sap and the descent and assimilation of the cambium as to cause the death of the tree. "The female insect commences its injury about July by boring through the bark, until she has reached the part between the soft wood and inner bark, when she forms in the latter a vertical channel usually upwards of two inches long, on each side of which she deposits her eggs as she advances to the number of from 20 to 50. About September the larvæ are hatched, when they commence feeding upon the matter of the inner bark, at the edge of the channel, and in a very slight degree on that of the soft wood opposite, advancing as they feed, in a course of about right angles from the primary channel and on each side of it. When the larva has finished its course of feeding, it stops in its progress, turns to a pupa, and then to a beetle; after which it gnaws a straight hole through the bark and comes out. The beetles come out about the latter end of May, in the year following that in which the eggs are deposited; the sexes afterwards pair, and the female, bearing eggs, bores through the bark, and so on from generation to generation, and from year to year. The infested trees may be easily recognised, as the bark will be found perforated by small holes, as if made by a shot or broad-awl, in several parts, whilst small particles like saw-dust will be found on the rough surface of the bark, and at the foot of the tree. The scolyti never attack dead trees; they seldom destroy the trees they attack, the first year that they commence their ravages; and they prefer a tree that they have already begun to devour, to a young and vigorous tree. It is stated that at least 80,000 have been known to attack a single tree. From observations made, it appears that the females never deposit their eggs in trees perfectly healthy, but that both they and the males pierce young and healthy trees for the purpose of eating the inner bark which constitutes their food, and that the numerous holes they thus cause, partly from the loss of sap which exudes from them and the absorption of rain which lodges in them, will bring the trees in which they occur into that incipient state of ill health, in which the females select them for laying their eggs, and that thus healthy trees are effectually destroyed by the combined operations of the scolyti of both sexes, though not solely in consequence of the depositure of

the eggs of the female. The practical directions resulting from a knowledge of the economy of the scolytus when there is reason to suspect its presence, are first to pare away the exterior rough bark with a cooper's spokeshave or other convenient tool, thus admitting of a distinct inspection of the actual state of the trees, which, if having no trace in the inner bark either of small holes in old trees, or those superficial furrows which they make for food in young trees, may be pronounced sound and healthy, and to require no further attention. If the inner bark should exhibit any of these appearances, it is next to be ascertained whether the female has already deposited her eggs in it, and if it contain larvæ, (which may be known by cutting away portions of the bark down to the actual wood,) should their existence be proved, the trees should be cut down, the bark peeled off, and every fragment carefully burnt. Trees which have been merely pierced for food, may be carefully brushed over with coal tar, the smell of which is highly offensive to the insect; and when this is repeated for a year or two, they are enabled to resume their vigour, and grow healthy."

The drawf scolytus, *S. pygmæus*, is sometimes associated with the preceding species in the work of ravaging the elm, but is more generally, and somewhat distinctively, a devastator of the oak. Its length is not more than one line and a half; its body is black, smooth, and shining; its head is strong and granulated; its thorax with the anterior margin is sometimes reddish; its elytra are rust red and closely punctate-striate; its abdomen is retuse; its legs are pitch-red; and its antennæ also are red, but of a lighter hue than the legs. This insect abounds in France, and made such havoc on a somewhat recent occasion, in the Bois de Vincennes that 50,000 young oaks had to be cut down in consequence of its attacks; and though hitherto undetected in connexion with any devastation in Britain, it may possibly, at some future day, make as sudden and desolating an appearance among the oaks of our country as the destroying scolytus has done among the elms, and requires therefore to be known.

SCOPULA. See Pyralis.

SCORPION-GRASS,—botanically *Myosotis*. A genus of ornamental herbaceous plants, of the borage family. Seven species grow wild in Britain; upwards of a dozen have been introduced from other countries; and between 20 and 30 more are known. Some are annuals, and others radical perennials; some are aquatics, and others frequent very dry situations; some are trailing or procumbent, and others are more or less upright; some possess little interest, and others are among the most exquisitely beautiful small-flowered plants in the world. The great majority have blue flowers; and all the very handsome ones are well represented by the well-known perennial-rooted indigenous species noticed in our article Forget-Me-Not. All the species, when grown in gardens, will thrive in any common soil; and most of the perennial ones are propagated by radical division, and all the annual ones, and the rest of the perennials, from seeds.

The tufted scorpion-grass, *M. cæspitosa*, is an indigen of watery places in Britain. Its roots are perennial; its stems are 9 or 10 inches high; and its flowers are blue and very beautiful, and bloom in June and July. A long calyxed variety of it, *M. c. macrocalyx*, occurs wild.—The intermediate species, *M. intermedia*, is an indigen of the dry woods of Britain. Its roots are perennial; its stems are procumbent and about 6 inches long; and its flowers are very handsome, and bloom in April and May.—The rock species, *M. rupicola*, is an indigen of rocky situations on the lofty mountains of Scotland. Its roots are perennial; and its flowers are blue and beautiful, and bloom in June and July.—The wood species, *M. sylvatica*, is a perennial-rooted weed of the woods of Britain. It has a height of about a foot, and blooms in June and July.—The corn-field species, *M. arvensis*, is an annual, blue-flowered weed of the dry fields of Britain. It has a height of about a foot, and blooms from spring till autumn. A handsome white-flowered variety of it, *M. a. alba*, occurs in gardens.—The party-coloured species, *M. versicolor*, is also an annual weed of the dry fields of Britain. Its stems are about a foot high; and its flowers are blue and yellow, and bloom from April till June.

The Azorean species, *M. azorica*, grows about waterfalls, streams, and wet rocks in some of the westerly islands of the Azores, and was introduced to Britain in 1844. It is a perennial, scarcely hardy, about two feet high; and it resembles our native forget-me-not, but has larger flowers, of a deep indigo blue colour, and is more prolific of bloom on its numerous lateral branches. It needs a moist atmosphere.—The dwarf species, *M. nana*, was introduced about 48 years ago from Continental Europe. It also is a perennial, and presents a close resemblance of flower to the forget-me-not; but blooms only for a short period, and is only 4 or 6 inches high, and has the recommendation, while in bloom, of displaying a great profusion of flowers comparatively to the bulk of its herbage.

SCORPION SENNA. See Coronilla.

SCORPIURUS. See Caterpillar.

SCORZONERA. A genus of exotic herbaceous plants, of the succory division of the composite order. About 30 species—all hardy, chiefly perennial-rooted, mostly yellow-flowered, and varying in height from 6 inches to 3 or 4 feet—have been introduced to Britain; and a few more are known. Most of the introduced species are more or less ornamental, and flourish on any ordinary soil, and may be propagated either from seed or by radical division.

The Spanish species, *S. hispanica*, was introduced in the latter part of the 16th century; and

has long been cultivated in kitchen gardens for the sake of its esculent root; but is now in much less request than at former periods. Its root is carrot-shaped, and about the thickness of a finger, and is white within, and has a milky juice, and is covered with a dark brown skin; its stem is smooth, and branches at the top, and is garnished with a few half-sheathing leaves, and has a height of about 3 feet; its lower leaves are acutely pointed, waved and sinuated, and about 9 or 10 inches long and 1½ inch broad in the middle; its upper and half-sheathing leaves are linear; its flowers grow in scaly calyxes, and comprise many narrow tongue-shaped florets, lying imbricatedly like the scales of a fish, and have a bright yellow colour, and bloom from June till September; and its fruit contains a mass of oblong cornered seeds, and has at the top a roundish ball of feathery down. This plant is raised, for culinary purposes, from seed sown in April or May; and must, for prolonged use, be raised in proper succession, as it sometimes runs to seed in the same year in which it is sown. It thrives in any common soil; and it may be sown either broadcast or in drills, but must be thinned out to distances of about a foot from plant to plant. The roots of plants sown in April and May are in full growth for use in autumn and winter; and they are eaten boiled. The name scorzonera is derived from a word signifying "viper;" and both it and the popular name of viper-grass were given to the plant in allusion to some fancied medicinal power.

SCOTCH ASPHODEL,—botanically *Tofieldia Palustris.* A curious, indigenous, evergreen herb, of the melanthium tribe. It grows wild on upland bogs, and on the marshy banks and neighbourhoods of pools and rills. Its root is woody; its stem is solitary and about 4 inches high; its leaves grow in two-ranked radical tufts, and are ensiform, ribbed, incurved at the point, and about two inches long; and its flowers are produced at the top of the stem in a small oblong spike or head, and are greenish-white and inodorous, and bloom in July and August.

SCOTCH FIR. See PINE.

SCOTCH KALE. See BORECOLE.

SCOTCH LABURNUM. See LABURNUM.

SCOTCH LILAC. See LILAC.

SCOTTIA. A genus of ornamental, Australian, evergreen shrubs, of the genista division of the composite order. Two species, both about 3 feet high, the one with red and green flowers, and the other with yellow and scarlet flowers, have been introduced to the greenhouses and conservatories of Britain.

SCOURING. See PURGING, DIARRHŒA, and DYSENTERY.

SCRATCHES. Troublesome ulcerations about the heels of horses, occasioned by ill-treatment, negligence, and filth. They are a virulent kind of cracks, and are frequent concomitants of grease. See the article GREASE.

SCREENING. The sifting of earth or seeds or mixed dry substances through a large oblong sieve or riddle, called a screen.

SCREW-PINE. See PANDANUS.

SCREW-TREE, — botanically *Helicteres.* A genus of ornamental, tropical, evergreen shrubs, of the bombax family. Nearly a dozen species, varying in height from 6 to 14 feet, have been introduced to the hothouses of Britain; and some more are known. The leaves of some are heart-shaped and marshmallow-like; and the flowers of most are either red, brown, purple, yellow, or white. The Isore species, *Helicteres isora,* may be regarded as the type of the whole genus; and has the rank in India of a medicinal plant, and was introduced to Britain in 1733. It attains a height of 12 or 13 feet, and is very branchy or bushy, and carries yellow flowers in June and July. Its root and its fruit are the medicinal parts;—and the latter is a contorted capsule, consisting of five fibres twisted in the shape of a screw; and varies in length from one inch to 2½ inches; and is alluded to in both the popular and the botanical names of the genus,—the latter being formed from a word which signifies a screw. The juice of the root has the reputation, among some Indian pharmacists, of being a powerful stomachic; and a liniment, prepared with the powder of the fruit, is supposed to be a valuable application in cases of offensive sores inside of the ears. All the species of screw-tree in British collections love a soil of peaty loam, and are propagable from cuttings.

SCROPHULA. A deep-seated and malignant cutaneous disease, popularly called the king's evil. The name is derived from a word signifying a sow, and was suggested by the fact of swine being subject to the disease. But sheep also are sometimes attacked with a very virulent kind of scrophulous malady, which, in their case, is sometimes called 'the evil,' and sometimes bears other names. This malady is first indicated by a hard swelling of the glands under the jaws; it afterwards throws out about the head and the neck, a succession of small pustules, which break, and discharge a white matter, and heal, and multiply; and it eventually debilitates and emaciates its victims till they sink into irretrievable weakness and die. It rarely attacks more than a few individuals of a flock. The only known remedy for it is iodine; and this has been somewhat successfully used in the forms of hydriodate of potash administered in a daily dose of 4 or 5 grains in gruel, and of ointment of iodide of mercury rubbed upon the pustulated parts.

SCROPHULARIA. See FIGWORT.

SCUFFLER. See GRUBBER and HARROW.

SCURVY-GRASS, — botanically *Cochlearia.* A genus of herbaceous plants, of the cruciferous order. Four species grow wild in Britain; 9 or 10 species, all hardy, and chiefly white-flowered and but a few inches high, have been introduced from other countries; and about 20 other species

are known. The four indigenous species comprise the main interest of the genus; and the most important one of these is noticed in the article HORSE-RADISH.

The officinal scurvy-grass, *Cochlearia officinalis*, occurs on the sea-shores and on some of the uplands of Britain, particularly in the north-west of England. It is a biennial, of fleshy texture and smooth surface, and varies greatly in height, yet is most frequently about 6 or 7 inches high. Its stem is angular, leafy, and branching; its radicle leaves stand on long footstalks, and are kidney-shaped, subdentate, and spreading; its cauline leaves are alternate, sessile or sheathing, oblong, and angularly sinuated; its flowers grow in terminal corymbs, and have a white colour, and bloom in April and May; and its fruit are globose silicles, each crowned with a very short style and somewhat roughish. The fresh plant is eaten in the way of salad, as a stimulant, a diuretic, and an antiscorbutic; it has a bitter acrid taste, and emits a pungent odour when bruised; and it yields by distillation a volatile oil and sulphuretted hydrogen. The dried herb, however, whether in itself, or in powder, or in infusion, has none of the active properties or taste or flavour of the fresh herb. Two varieties of a somewhat ornamental character occur wild,—the smaller, *C. o. minor*, and the round leaved, *C. o. rotundifolia*. The plant is raised in the kitchen garden from seed, sown in a damp sandy soil, early in the autumn, in drills 8 inches apart.

The English scurvy-grass, *C. anglica*, is an annual indigen of the sea-shores of Britain, and has a height of 6 or 7 inches, and blooms in May. —The Danish scurvy-grass, *C. danica*, is also an annual indigen of the sea-shores of Britain, and has a height of 3 or 4 inches, and blooms in May and June.—The Greenland scurvy-grass, *C. gronlandica*, is a biennial indigen of some of the lofty mountains of Scotland, and has flesh-coloured flowers and a height of 6 or 7 inches, and blooms in May and June.—All these three species, as well as the officinal scurvy-grass, have an economical character.

SCUTELLARIA. See SKULLCAP.

SCYTHE. An implement for mowing. A general view, both of the common scythe for cutting down herbage crops, and of the cradle scythe for cutting down corn crops, has been given in the article MOWING; and any particular account, descriptive of the many varieties and modifications of each kind, seems unnecessary; for districts of country and individual mowers are so firm in their respective tastes and so wedded to their respective habits, that, for the most part, each works best with his own favourite varieties of the implement.

The common grass scythe does very well for mowing upright crops of oats and barley; but even when furnished with a bow, it cannot lay evenly down a heavy crop of wheat, or duly deposit it at right angles with the standing corn for the convenience of the binders. The cradle scythe is much modified in its powers and action by the form and comparative length of the handle, and by the form and materials and mounting of the cradle. Drummond's iron handled scythe is a very efficient implement in the hands of a good mower who likes it or has become accustomed to it, cutting down from $1\frac{1}{2}$ to $2\frac{1}{2}$ acres in the day, and serving equally well to "cut out" or to "cut in;" and the short-handled scythe of Aberdeenshire has a high provincial reputation, especially for the mowing of heavy or of lodged crops. The Hainault scythe, an implement of medium character between the true scythe and the sickle, is noticed in the article HAINAULT SCYTHE. See also the articles REAPING, HAY-MAKING, and SICKLE.

SEA-BANK. See EMBANKMENT.

SEA-BLITE. See GOOSEFOOT.

SEA-BUCKTHORN. See BUCKTHORN (SEA.)

SEA-DAFFODIL. See PANCRATIUM.

SEA-HEATH. See FRANKENIA.

SEA-HOLLY. See ERYNGO.

SEA-KALE,—botanically *Crambe*. A diversified genus of plants of the cruciferous order. One species grows wild in Britain; nearly a dozen species have been introduced from other countries; and several other species are known. About one-half of the species in Britain are hardy tuberous-rooted herbs, and have the lower joint of the silicle thick and depressed; three or four are hardy annuals or biennials, and have the lower joint of the silicle elongated and cylindrical; and two are greenhouse evergreen undershrubs, and have the lower joint of the silicle short and filiform. The tartarian species, *Crambe tatarica*, a tuberous-rooted, white-flowered herb, of about 3 feet in height, blooming in June and July, and introduced to Britain about 60 years ago from Siberia, is a culinary plant; and the heart-leaved species, *Crambe cordifolia*, a tuberous-rooted, white-flowered herb, of 6 or 7 feet in height, blooming in May, and introduced about 26 years ago from Caucasus, possesses a somewhat ornamental character; but all the other introduced species are comparatively uninteresting.

The indigenous or common sea species, *Crambe maritima*, concentrates in itself the main interest of the genus, and often makes a complete monopoly of its name. This plant inhabits the shingles and rocks and cliffs and sandy downs of the shores of the south and west of England, of some parts of Scotland, and of Denmark and Sweden. Its roots are large, tuberous, fleshy, and much divided at the crown, and spread so much underground as rapidly to propagate the plant; several stems rise from each root, or set of roots, and are branched, spreading, and leafy, and have a height of from 12 to 24 inches; the leaves are stalked, spreading or deflexed, large, undulated, toothed, of a leathery texture, very glaucous, smooth, and rather succulent,—the lowermost

somewhat lyrate, and the rest roundish acute; the flowers grow in dense terminal clusters, and are fragrant and have a milk-white colour with a yellowish centre, and bloom in May and June; and the silicles are round, smooth, and about the size of black currants, and contain each a single seed.

The inhabitants of the coasts on which sea-kale grows wild have, from time immemorial, been in the habit of searching for its young shoots as they emerge from the sand and gravel, and cutting them under the surface, and using them as a highly esteemed and delicate pot vegetable. Boys also procure them, in a hazardous manner, from the crevices of sea-cliffs, by letting themselves down from above with ropes. Yet sea-kale, in all the circumstances of its wild condition, even when obtained in the most tender and blanched state, is merely a species of green kale; while it can be rendered by culture an exceedingly delicate vegetable, of the same category of esculents as asparagus, but preceding that choice plant in the season, and combining much of its peculiar flavour with that of the best borecole or chou de Milan. The young spring shoots rising from the root are the chief parts used; and they have a thick substance, and, when artificially well blanched and cut in a sufficiently early stage of their growth, they are both tender and finely flavoured. The ribs of the large leaves, also, are peeled and dressed like asparagus.

Sea-kale was sent from England to the Continent, by Lobel and Turner, before the middle of the 16th century; yet it was botanically described for the first time by Miller in 1731; and was not brought into repute as a garden vegetable till Dr. Lettsom introduced its cultivation in 1767. But it has now a place in almost every good or extensive private kitchen garden; and it forms a profitable article of attention with market-gardeners, generally meeting a ready sale, and bearing a comparatively high price. It requires some peculiarity of treatment, yet can be quite easily cultivated; and, while so perfectly hardy as to withstand any ordinary frost, it is one of the finest possible subjects for forcing, always possessing more crispness and delicacy when forced than when raised in the natural way. It can be raised from seeds, and brought to the table early in the second year after sowing; and it can likewise be multiplied, and modified, and propagated abundantly, at any season of the year, by means of offsets from the shoots or division of the roots, and then transplanted, trenched, and blanched. The following directions for cultivating it are taken from a paper by Mr. Towers, the well-known author of the Domestic Gardener's Manual:—

"The soil, as indicated by the native situation and habits of the plant, should be light and sandy, with a slight addition of mild lime, muriate of soda, and wood ashes. The beds ought to be prepared as for asparagus; and of a light sandy turf, with a natural manuring of sea-weed alone, or artificially with one-fourth of a compost consisting of perfectly reduced fern, or leaf-mould, nine parts, wood ashes, one part, and about half a pound of common salt to every barrow-load of the compost. This last chemical compound contains a large proportion of the components of sea-water, and the wood ashes yield carbonate of lime in its most effective state, also some carbonate of potash and fine silex. Three barrows of light sandy turf, and one barrow of the above compost, give proportions which promise to yield a medium of growth of the most permanent and effective character. In it sea-kale and asparagus might be grown for forcing, either side by side, or in separate plots. But if neither turf nor sea-weed can be obtained, good kale can be produced in any light garden soil, trenched in the same manner as for asparagus beds, and manured copiously with wood (not coal) ashes, and the prescribed quantity of common salt. All the difference in the two beds is this, that for sea-kale, or forced asparagus, the plot of ground should be large enough to permit the plants to stand in single rows 3 or 4 feet apart. The rows may be of any required length according to the quantity likely to be consumed. Supposing that 6 or 8 rows, each 12 feet long, be required, then the ground is either to be trenched 20 inches deep at the least, or dug out and replaced with the enriched turf; and the work ought to be completed before March, so as to become settled by the middle or latter end of that month. Between every row there should two stakes be set up at each end, two feet asunder; these will mark the beds and the spaces between them; thus there may be 8 beds and 9 spaces or divisions. At the time of sowing the beds—(I greatly prefer seed to plants)—leave a space on the outside of two of the outermost stakes, and strain a garden line exactly along the middle of the bed immediately within, and next to it; and beginning at one end of the line—but a foot within it—make a small ring or circle with the finger, an inch deep, and three inches wide; or what is better, force a circular piece of iron or wood into the ground to the required depth, and drop three seeds in the ring so formed, equidistant, and at right angles with one another. Form and sow the rings about fifteen inches asunder—centre from centre, the whole length of the line; then cover the seeds to the surface depth with sand, and pat it to a level with the flat of a spade; one row or bed will thus be sown. Leave the adjoining space of two feet vacant; and proceed to the bed or division next beyond it: sow that, and proceed in the same alternate order till the plot be completed; when a space exterior of the last sown division must be left, and it will then be found that whatever be the number of divisions sown, that of the unsown spaces will exceed it by one. The plan thus laid down is grounded upon the practice of the celebrated Bath cultivators; and nothing can exceed it for the facility it affords to good tillage, and orderly, convenient forcing. If the seed be good, the season propitious, warm, and moist, germination will rapidly advance; and when the plants appear, they may be secured from vermin by sprinkling around and within them a good covering of wood ashes, three parts, blended with soot and powdered lime, of each one part. If weeds arise and threaten to surmount the plants, they must be kept under by surface-hoeing to the depth of an inch, with the Dutch or thrust-hoe. Perhaps three plants will rise from each ring, and these, and indeed all that grow, must remain till they begin to interfere with each other; then, one only, the strongest, must be left, and the others drawn or raised up; so that a complete row of single plants, from 1 foot to 15 inches apart, finally remain. The young supernumeraries may be set out in rows, to grow for succession, or be thrown away if no more stock be re-

quired. The plants in the rows will grow luxuriantly, and become very large, so much so as, in all probability, to come in contact, forming one connected line of sea-green foliage. All the culture during the summer and autumn, will consist in keeping the beds clear from weeds, and in digging the alternate spaces two or three times, to the depth of 9 inches, so as to pulverize and render the soil as fine as possible. At the two last operations (say in July and October), it would be as well to incorporate with the soil a two-inch layer of decayed leaves, mixed with one-fourth part of pure wood-ashes. The reader will be very careful to avoid sea-coal or even pit-coal ashes. It formerly was the custom to cover sea-kale with conical hills of those ashes during winter, and one out of three or four plants perished, the damage being ascribed to mice or moles. I never have lost a plant since I left off that acrimonious chemical compound, styled ashes, nor could I, by any means, keep my bed entire while I employed it. Its destructive influence has at length been admitted, and sea-kale now enjoys a regular growth, and repays its cultivator. No forcing ought to be attempted during the first winter; but it would not be amiss, after clearing off all the old leaves, to strain a line along the edges of the beds, and, cutting the earth by it three inches deep, to mould up the two feet beds with the earth taken to that depth from the intermediate spaces. A tall marking stick should, however, be placed near the centres of the plants. After the earthing up, a blanching-pot, wooden box, or old bee-hive, is to be set over every plant. A straw-hive is indeed an excellent material. It is sufficiently strong, warm, and impervious to light, even when used alone, without leaves, for blanching. A small or even a very tolerable gathering of fine white kale will be the result of this treatment, earlier or later, according to the season and climate; and, in cutting it, the knife should be passed below the surface of the stratum of soil that was added, so as to bring up each full-sized shoot in a compact state, and not in detached leaves. The smaller sprouts ought not to be cut; and, when all the large ones have been taken, the superposed soil should be drawn back into the spaces, and the whole plot reduced to an even surface-level. This work will, it is presumed, be performed about mid-April, and then a knife, or very sharp-edged spade, should be passed through the shoots, so as to cut off every one that rises above the original level of the bed. This cutting will induce the plants to send forth a number of fresh shoots, and prevent, in a degree, the protrusion of flower-stems. The routine culture of the second season will comprise weeding with a flat hoe, digging and enriching of the spaces, as before directed, and the immediate excision of every flower-stem that may be sent up. After the leaves have become inactive, remove them. Mark each plant with a tall stick, and dig and mould up the beds with fine earth from the spaces, as in the previous season; but now, and in each succeeding year, dig out, and remove to a spot at hand (as convenience may point out), the earth of each space, on the sides of those rows which are to be excited, so as to leave trenches one foot deep. The plots ought to be so contrived as to furnish three distinct forcings,—the first to commence late in November, to be cut at the close of the year; the second, about the first week in January; and the third, early in February. A fourth reserve ought to come in at the natural season, blanched, but not forced, in April. The trenches are to be filled to the level of the tops of the line of pots or covers with tree-leaves, blended, if possible, with one-third part of fresh stable-manure. When this level is attained, the pots and spaces between them must be covered to the depth of two feet with the same materials. The bed of fermenting material ought to form a compact mass of equal depth; and this it will be advisable to cover with straw hurdles or thatch, to keep out excessive rains, and to retain the developed heat. Trial-sticks should be thrust deeply into the masses; and if these, on being withdrawn, feel gently warm, the work of forcing will proceed regularly, and kale will be procured in succession from Christmas to the end of March, to be succeeded by the crops from the unexcited bed. After forcing and clearing off the leaves, &c., the trenches are always to be filled up, and the surface-level restored."

SEA-LAVENDER. See STATICE.

SEAM. Tallow, hog's lard, or any other prepared, solid animal fat; also, a quarter of grain; also, a horse-load of wood.

SEA-MATGRASS. The *Psamma arenaria* or *Ammophila arundinacea*. See ARUNDO.

SEA-MILKWORT, — botanically *Glaux*. A small, handsome, evergreen, indigenous plant, of the salicaria family. It constitutes a genus of itself, and takes the specific name of *maritima*. Its name glaux alludes to the colour of its leaves, and its name maritima to its habitat in salt marshes. It is also sometimes called black saltwort, in allusion to the saltishness of its taste. The stem is densely leafy, and 3 or 4 inches high; the leaves are entire, elliptico-oblong, and smooth; and the flowers are axillary, solitary, and nearly sessile, and have a flesh-colour, and bloom in May and June. The plant may be raised from seeds, and cultivated in an open sandy loam.

SEAM-PRESSER. See ROLLER.

SEA-MUD. See MUD and SEA-OOZE.

SEA-OOZE. The sediment of sea-water around bays and friths and the mouths of rivers. It is a compound of finely comminuted earths, calcareous matters, saline substances, and animal and vegetable remains; but materially varies in composition, as found in different localities, according to the form of the beach, the strength of the sea-water, the action of the winds and currents, and especially the character of the alluviums and drainages brought down by the adjacent rivers. It is, in every case, a good manure; but, on most soils and for most purposes, it acts best when it contains a fair proportion of calcareous matter, or freely effervesces with any of the common acids.

Sea-ooze has been extensively and advantageously used as a spring top-dressing for grass lands. It also does well, in some places, to be spread on old lea, and ploughed in, without any addition, in the following spring, preparatorily to a rotation of oats, potatoes, wheat, and either oats and barley with clover and grasses; and has been found, when used in this way, to produce great crops, and to exert a more durable and much less critical or doubtful influence than marl. It has likewise been employed, with mighty and very enduring effect, as a fertilizer of moss lands; but requires, in this capacity, to be applied in the large dose of about 100 one-horse cart loads

per acre; and is liable to prove comparatively inert if applied a second time to a piece of moss-land which it formerly fertilized.

A judiciously formed compost of sea-ooze with whatever earths or other substances are most suited to the condition and wants of the soil to which it is to be applied, serves as an excellent top-dressing for either grass or wheat in winter, and acts very fertilizingly on thin poor pastures, and effects surprising improvement on almost every kind of garden soil. "Sea-ooze, when applied to land in tillage," says Sir John Sinclair, "ought to be mixed with the soil, as soon as possible after being brought out of the water. One part of ooze and two parts of peat-moss, make an excellent compost. Of this, twenty cart-loads (about 1¼ cubic yard each) will produce an excellent effect upon an acre of land for barley, or indeed any kind of grain. Peat, when drenched in sea-water, is to be preferred. When peat cannot be got, the ooze may be compounded with earth and other substances."

SEA-PARSNIP. See SAMPHIRE (PRICKLY).

SEA-PIE. See OYSTER-CATCHER.

SEA-REED. See ARUNDO.

SEA-ROCKET. See CAKILE.

SEA-SAND. See SAND.

SEA-SHELLS. See SHELLS.

SEASIDE BALSAM. See CROTON.

SEASIDE GRAPE,—botanically *Coccoloba*. A genus of ornamental, evergreen, tropical shrubs and trees, of the polygonum family. About 20 species, varying in ordinary natural height from 8 to about 90 feet, have been introduced to Britain from the West Indies and the hot parts of Continental America; and several more are known. Their calyx is fleshy and coloured; their fruit is berry-like and grows in clusters; and the favourite habitat of some of the best known is the sea-board. Hence both the popular name of seaside grape, and the botanical one of coccoloba,—the latter signifying "a lobed berry." The fruit of some, though very astringent, is eaten by the natives; and the wood of the tallest and bulkiest is used as timber.

One of the smallest in size and earliest known may serve as a sufficient specimen of the whole. This grows on the sandy shores of the West Indian islands. Several stalks rise from each root, and attain a height of from 8 to 10 feet, and are garnished with foliage and clothed with a light brown smooth bark. The leaves are alternate, and stand on short footstalks, and are very thick and stiff and almost round, and have a diameter of from 5 to 7 inches, and are lucid green above and veined below. The flowers come out from the wings of the stalks in long slender bunches like those of the common currant, and have white six-parted petals, and are succeeded by purplish-red berries about the size of common grapes, each enclosing a nut of its own shape.

SEASIDE OAT. See UNIOLA.

SEASON. One of the four great natural divisions of the year,—spring, summer, autumn, and winter. In a general view, in reference to plants, spring is the season of germination; summer, of blooming; autumn, of fruiting or seeding; and winter, of repose. The natural periods and duration of any one season always differ more or less from those fixed artificially in the calendar, and sometimes differ very widely, and are far from being uniform in successive years. The stages of tillage and cultivation, therefore, ought to be regulated far more by the natural phenomena of the seasons than by their mere calendarial divisions and dates. The word season is also used to designate the whole of the active period of one year, as distinguished from the inactive period, or the whole of the period between the sowing and reaping of an annual crop as distinguished from the period of the ground being unoccupied. It is likewise used to denote the fit time of the year or the fit condition of things for the performing of any specific operation,—as the season for ploughing or for sowing,—the season for barking trees or for felling them.

SEASONING. The rendering of food relishable by the addition of some condimental substance, or the maturing of a dead organic material for use by bringing it into a suitable and permanent condition.

SEAVES. Rushes. Seavy ground is ground overgrown with rushes. But the expression is provincial, and, in a great degree, obsolete.

SEA-WALL. See EMBANKMENT.

SEA-WARE. Fuci, together with intermixed substances, found in large quantities on the sea-shore, and used by farmers and gardeners as manure. The fuci are described in the article FUCI; and one important economical purpose for which some of them were formerly employed, is noticed in the article KELP. The fuci found still attached to the rocks are often called black ware; and those found in a loose state, cast ashore after storms, are often called red ware or loose ware, or par excellence sea-ware; and both kinds bear also the popular names of sea-weed, sea-wrack, and tangles. The substances usually intermixed with them are sea-water, shells, molluscs, exuviæ, and sand.

The black ware may be cut and gathered in the same manner as in former years for kelp. It is not so easily acted on by moisture or the atmosphere as the red, and is longer in decomposing either as a top dressing or as an incorporated manure, and is not so suitable for any purposes which require promptitude and rapidity of fertilizing action; yet it may be advantageously used either in decomposing moss, or in mixing with soil to make a compost, or in reducing stable dung and bringing it to a state of fermentation, or in littering cattle during a scarcity of straw; and, in districts where it is in request at a considerable distance from the coast, or at other seasons of the year than spring or winter, it may be spread out on the shore to dry,

and then stored up in ricks or stacks in the same manner as hay, and finally carried inland, when wanted, at one-fourth or one-sixth the cost of fresh, wet ware.

The red ware—or, par excellence, sea-ware—is sometimes cast ashore in great quantities, and always comes very irregularly, and is controlled by winds, tides, and currents, and may be swept away again the very next tide after it arrives; so that it needs to be closely watched, and must be taken just when it can be got, and ought always to be promptly gathered and immediately carted or boated off. A vast trade in it is carried on by the fishermen of the rugged and sinuous coasts in the vicinity of some of the larger ports of the west of Ireland. It needs no preparation for manurial use, as it contains no woody fibre, or other stubborn principles requiring chemical reduction; and it is always most profitable when applied in as recently gathered state as possible, for it loses both bulk and fertilizing substance by exposure, drying, or fermentation.

Fresh sea-ware produces very powerful fertilizing effects, but generally does not act longer than a single season. It consists organically of cellular tissue, and contains a very large proportion of water, or of the elements of water; and, when simply exposed to the air, either on the surface of the ground, or within the upper part of the soil, it melts and mainly disappears without evolving any appreciable heat. It contains much soluble mucilage; and passes largely, by brief or rapid fermentation, into carbonic acid and watery vapour; and probably offers copious supplies of the former of these proximate principles in solution in water for absorption by the spongioles of growing plants of the field. It was formerly thought to fertilize chiefly by means of carbonic acid, and to be neither a nitrogenous manure, nor a very good saline one; but, though it certainly emits, in the process of decomposition, a very different odour from that of nitrogenous land plants, it has been ascertained, in some instances, to contain a greater proportion of nitrogen than even ordinary farm-yard manure; and, in as far at least as it is identified with the kelp-yielding fuci, it is known to excel almost all other fresh vegetable substances, bulk for bulk, in the amount of its saline principles. "Much of the fertilizing power of sea-weeds," says Dr. Shier, "is no doubt due to the large quantity of alkaline and earthly salts they contain. The proportion of alkaline salts varies considerably in different species; so much so, that kelp-burners use chiefly the firm coriaceous species that grow about and under low water-mark; such as the *Fucus digitatus, F. nodosus, F. saccharinus*, &c., while they reject or account of much less value, the *Fucus serratus, F. vesiculosus, F. canaliculatus*, and others that grow in shallower water. In the absence of accurate analyses of the inorganic part of these plants, it is not possible to speak with precision of their relative values; but on the shores of the north of Scotland, I have uniformly found that the most observant farmers, who have had much experience in the use of sea-weeds as a manure, manifest the same preferences as kelp-burners."

Sea-ware, in a fresh state, acts admirably when laid on stubbles before winter ploughing, and on leas before being ploughed for oats, and on wheat fallows before the seed-furrowing. The late Dr. Browne of Gorlstone, in Suffolk, records, that, in October, 1819, he spread 27 huge cart-loads of loose sea-ware, fresh and wet, upon little more than an acre of bean-stubble, instantly ploughed it in, and dibbled wheat upon it,—that in the same month he manured the adjoining land with 3 bushels of salt and 15 loads of farm-yard manure per acre, and on the 15th of November dibbled it with wheat,—and that, as the result of this comparative trial, the sea-weeded portion gave three times the produce of any equal part of the field.

Sea-ware is an excellent top-dressing for grass lands, under the alternate husbandry, both producing a rich covering of deep green grass, and predisposing the land very favourably for the succeeding grain crop; and when laid on the grass in either summer or autumn, it rapidly disappears, and soon becomes traceable only in its effects. Some farmers and many market-gardeners, particularly on some of the eastern sea boards of Scotland prefer sea-ware to all other manure for cabbages, borecoles, and other succulent green crops which are liable to become rank and bitter when grown after farm-yard manure. Many cottiers and small farmers, especially in Ireland, and also some large cultivators, applaud and practise the use of it in drills as a manure for potatoes; but others condemn this use of it as injurious to the mealiness and flavour of the tubers.

A grand use of sea-ware, or rather class of uses, is to treat it as a main and modifying ingredient in composts. "The quality of earthy composts and of farm-yard dung," remarks Mr. Donaldson, "is prodigiously improved by a mixture of sea-weed. In these cases, it is laid on the top of the heaps before they are turned over, and a bottom of loose friable earth is generally provided to absorb the oozings of the mixture. Sea-weed is very profitably used in mixing the farm-yard dung in the yards in thin layers alternately with straw; and manure of a most excellent quality has been produced by this method. During the seasons of sea-weed coming on the shore, the farmers have heaps of dung or soil in readiness to receive the immediate benefit of the wrack; and these heaps, along with any lands that may be in a state fit to receive it, afford a ready application of this invaluable article. Farm-yard dung for turnips is improved by it almost beyond description; moisture is imparted, the straw is decomposed, and the whole mass is converted into a juicy mucilaginous state,

and never fails to vindicate the expectations of its effects."

SEA-WATER. The water of the ocean and of its inlets. A specimen of it analysed by Marcet contained 2·666 per cent. of chloride of sodium, 0·466 of sulphate of soda, 0·1232 of chloride of potassium, 0·5152 of chloride of magnesium, and 0·0153 of sulphate of lime; and a specimen from the North Sea, analysed by M'Clemm, contained 2·484 per cent. of chloride of sodium, 0·135 of chloride of potassium, 0·242 of chloride of magnesium, 0·12 of sulphate of lime, and 0·206 of sulphate of magnesia. Sea-water, as a comparison of these two analyses may suggest, varies somewhat widely in constituency in different latitudes and in different seas; it also varies, in any one sea near the coast, in rainy and in dry seasons, or within or without the sweep of fresh-water currents from rivers; and, in addition to its main saline constituents mentioned in the two analyses which we have quoted, it usually contains very minute or inappreciable quantities of ammonia, carbonic acid, silica, magnesia, iron, manganese, sulphuretted hydrogen, organic matter, carbonate of lime, phosphate of lime, and iodides and bromides. It has a specific gravity of from 1·0269 to 1·0285; and is heavier in the higher latitudes of the torrid zone than at the equator. It owes its saline taste to its chlorides and sulphates,—and chiefly to its chloride of sodium; and it owes its nauseousness to the combination of these with its small quantity of organic matter.

The continual evaporation of the ocean, aided by the action of winds, sends a supply of the salts of sea-water over the whole surface of the world, and constantly contributes them, through the medium of rain, for the enriching of soils, and for the nutrition of all salt-loving plants. The air hanging over any part of the sea always contains enough of common salt to make a solution of nitrate of silver turbid; and the leaves of plants growing to windward of sea-storms, even at the distance of from 20 to 30 miles from the shore, are sometimes covered with crystals of salt. Mere ordinary evaporation from the ocean, therefore, and especially a prevalence of sea-breeze in any stated direction, must be always an appreciable and sometimes a highly valuable source of the chlorides of sodium, potassium, and magnesium, and the sulphates of lime and soda and magnesia to the plants of the garden and the farm. Though the carbonate of lime in sea-water amounts to less than a twelve-thousandth part of the water's weight, it affords the incalculable myriads of corals and marine molluscs a sufficient supply for the construction of their habitations; and though the iodine in sea-water amounts to less than one-millionth of the water's weight, it is everywhere readily enough collected, absorbed, and assimilated by the Fucoideæ which require it as an aliment; so that if the quantity of salts evaporated from the ocean, and distributed by wind and rain throughout the world, were vastly less than it is, it could not fail to exert an appreciable and constant influence on vegetation. The comparative saline wealth or poverty of any piece of land, therefore, must materially depend on its distance from the ocean, or on the degree in which it is swept and watered by breezes and exhalations and rains from the sea.

Sea-water is sometimes used for saturating dung-heaps and fold-yards, at short intervals during dry weather, in places upon the coast where it can be obtained and applied at a trifling expense of labour. But the main or only useful purpose which it can serve in this way is to impregnate the heaps with its saline principles; and either this purpose may be quite unnecessary on account of the heaps themselves or the soil to which they are to be applied already containing a sufficient quantity of these principles, or it may be more facilely and cheaply accomplished by means of a sprinkling of bathing salt. A farmer should consider, also, whether his dung-heaps may not get more injury from the excessive moisture of the saturations than they can get good from the impregnations of saline principles. See the article Salt (Common).

SEA-WRACK. See Sea-Ware and Fuci.

SEA-WRACKGRASS. See Wrackgrass.

SEBÆA. A genus of ornamental, exotic, annual plants, of the gentian family. Five species, all late-bloomers and only a few inches in height, have been introduced to Britain, from Australia and Southern and Western Africa; and they require greenhouse treatment, and have severally white, yellow, brown, and red flowers.

SEBESTEN PLUMS. See Cordia.

SECALE. See Rye.

SECAMONE. A genus of exotic, evergreen, twining plants, of the swallow-wort tribe. The emetic species, *S. emetica*, possesses medicinal properties. It has a height of 6 or 7 feet, and carries white flowers, and was introduced to British collections about 32 years ago from India.

SECHIUM. See Choko.

SECRETION. The function by which a living organ selects and separates certain principles from the fluids which pass through it or upon it; also, the amassment of the principles which this function selects and separates, or the substance into which they are transmuted in their separated state. Secretion, in the former sense, either assimilates or expels,—either appropriates the separated principles as part of the living body to which the organ belongs, or drives them into a course of being rejected from it on account of their unfitness for its nutrition; and a secretion, in the sense of the principles themselves, is a proper or recremental secretion when destined to assimilation, and an excremental secretion or an excrement when destined to expulsion. The secreting organs, in both animals and plants, are principally glands, cells, membranes, and infinitesimal tubes.

SECURINEGA. See Otaheite Myrtle.

SEDATIVE. A medicine which diminishes irritability and represses spasmodic action. Narcotics are sedatives, but exert first a stimulating influence; and both these sedatives and others require to be used with caution, and are far too mighty agents to be handled by empirics and quacks.

SEDGE. See Carex.

SEDUM. A genus of ornamental plants, of the crassulaceous order. It has a very near relationship to the houseleek genus. Fourteen species of it grow wild in Britain; 50 species or upwards have been introduced from other countries; and nearly 30 more are known. All the species in Britain, except two or three, are hardy; and the great majority are perennial evergreen herbs. The leaves of almost all are alternate, fleshy, very succulent, and either flat, tumid, or cylindrical; and the flowers of most grow in cymes, and are either yellow, white, reddish, or purplish. Nearly all love a sandy loam; and all, except a few annuals and biennials, are propagated by division of the plant. Some of the indigenous species are sometimes called houseleeks; but the greater number are more commonly called stonecrops; and one of the best known is called Orpine, and has been described by us under that name. All the indigenous species are perennials.

The thick-leaved sedum, *S. dasyphyllum*, grows on old walls in England, and has a height of only 2 or 3 inches, and carries white flowers in June and July.—The six-angled sedum, *S. sexangulare*, also grows on old walls in England, and has twice the height of the preceding, and carries yellow flowers in June and July.—The glaucous sedum, *S. glaucum*, grows on barren sands in some parts of England, and has a height of only 2 or 3 inches, and carries yellow flowers in July and August.—The whitish-leaved sedum, *S. albescens*, also grows on barren sands in England, but is more rare than the preceding, and has a height of 5 or 6 inches, and carries yellow flowers in June and July.—The taper-leaved sedum, *S. teretifolium*, is a rare indigen of some parts of Herefordshire, and has white flowers and a creeping habit.—The rock sedum, *S. rupestre*, inhabits the rocks of various parts of England, and has a height of 2 or 3 inches, and carries yellow flowers in July and August.—The white sedum, *S. album*, also inhabits the rocks of England, and has a similar height to the preceding, and carries white flowers in June and July. A small flowered variety of it, with a trailing habit, *S. a. micranthum*, occurs in Gloucestershire.—Forster's sedum, *S. Forsterianum*, inhabits the rocks of some parts of Wales, and has a height of 2 or 3 inches, and carries yellow flowers in July and August.—The reflex-leaved sedum, *S. reflexum*, inhabits old walls in England and Scotland, and has a height of about a foot, and carries yellow flowers in June and July.—The acrid sedum, *S. acre*, also inhabits the walls of Britain, but has a height of only 2 or 3 inches, and carries yellow flowers in June.—A dwarfish variety of it, *S. a. diminutum*, occurs on some of the heaths of England; and a long-shooted variety, *S. a. elongatum*, is found in Suffolk.—The villous sedum, *S. villosum*, inhabits moist situations on the lofty mountains of England and Scotland, and has a height of 5 or 6 inches, and carries pink flowers in June and July.—The oblong sedum, *S. oblongum*, inhabits the rocks of Britain, and is very dwarfish or only an inch or two high, and carries white flowers in July and August.—The English sedum, *S. anglicum*, also inhabits the rocks of Britain, and is similar in height and bloom to the preceding; and a distinct variety of it called the Irish, *S. a. hibernicum*, occurs in Ireland, and comes into flower so early as June, and continues in bloom till August. A small-leaved and early blooming variety, *S. a. microphyllum*, occurs also in Britain.

SEED. The reproductive epitome of a phænogamous plant. It is the grand provision for continuing and multiplying vegetable species; and presents a considerable analogy in the vascular classes of the vegetable kingdom to an egg in the oviparous classes of the animal kingdom. Some chief things respecting the constitution of a seed have been stated in the articles Ovule, Cotyledon, and Albumen; respecting the uses of many seeds for food and for economical purposes, in the articles Alimentary Principles, Food of Animals, Oil, Oil-Cake, Linseed, Organic Chemistry, and some others; respecting defects and losses of artificially sown seeds, the saving of corn-seeds, and the management of hybrid seeds, in the article Agricultural Seeds; respecting the chemical changes which take place in the sprouting and growth of seeds, in the articles Germination and Malt; respecting the envelopes and the processes of ripening, in the articles Pericarp and Fruit; respecting the proper artificial depositing of seeds for growth, in the article Sowing; and respecting the species, properties, uses, and treatment of all the chief economical seeds, in the articles on the respective plants to which they belong, such as Wheat, Barley, Oat, Pea, Bean, and multitudes of others. We shall, in the present article, therefore, do no more than make a few descriptive statements respecting seeds in general, and add some important practical remarks respecting the principal species of seeds employed in agriculture.

Every seed, whether monocotyledonous, dicotyledonous, or polycotyledonous, contains the embryo or rudiment of a future plant, and comprises an ample and most beautiful provision for its protection during dormancy, and for arousing and feeding it at the time of germination. The foramen of the ovule or seed-vessel of the flower closes at the introduction of the pollen; the integument afterwards hardens; the juicy or pulpy contents increase and consolidate; nour-

ishment is conveyed through a placental canal; and the seed, or the fruit which contains it, when fully formed and in possession of all the organism and substance requisite for independent existence and subsequent reproduction, drops from the placental attachment, and therefore from the plant, and ever after retains a scar or hilum at the point where the attachment existed.

The forms, surfaces, and composition of seeds themselves, and of the carpel envelopes which enclose them, are exceedingly diversified, and exhibit the most minute and comprehensive adaptation to the nature and habitats of their respective plants, and afford thousands of most exquisite displays of the wisdom and goodness of the Creator. All have an organization and a constitution exactly suited to their own reproductiveness, and most, at the same time, have a prolificity and consistence and composition expressly adapted to serve as food or medicine to all the higher orders of animals; while some, in one and the same process, contribute their pericarps to the feeding of animals, and acquire preparation and excitement for their own office of reproduction. Starch, sugar, gum, oil, proteinaceous principles, alkaloids, and multitudes of peculiar compounds, are so wonderfully diversified in the different species, too, as, in all the endless diversities of climate, soil, form, and habit, to achieve most nicely the purposes of maintaining vitality, resisting injurious attacks of insects, and making preparation, by chemical change and progress, for both the extraneous office of affording food to animals and the intrinsic function of developing the embryo of the future plant. Coverings of amazing variety of kind, and all perfect and beautiful, protect the interior substance and organisms from the injurious effects of excessive heat or cold, or of undue dryness or moisture; and many of these, at the same time, constitute either food to animals or nourishment to the germinating seeds. See the articles Fruit and Pericarp. The contrivances for dispersing seeds, too, so that the plants which arise from them may find fresh soil to nourish them and ample space to grow in, are numerous and admirable. "Not only are the winds and the waters and animals put in requisition, and unconsciously employed in the operation of sowing and planting, but the seeds themselves are endowed in many cases with certain mechanical properties which aid their dispersion. Thus the awn of an ear of barley is so sensible to moisture, that it lengthens in damp and shortens in dry weather; and by this alternate extension and contraction, aided by the short and thick set prickles by which it is serried, it will in the course of a few mornings drag away the seed to which it is attached to some distance from its parent stalk. Thus, again, the seeds of the thistle and dandelion have a species of downy wings attached to them, by means of which they float through the air, and are carried by the wind to great lengths. And thus, too, the pods of the broom and furze are furnished with an elastic spring, which, on being acted on by the heat, forcibly ejects the seed, and with a considerable report, to a distance from the spot. 'Who,' says Sir J. E. Smith, 'has not listened in a calm and sunny day to the crackling of furze bushes, caused by the explosion of these little elastic pods, or watched the down of innumerable seeds floating on the summer breeze, till they are overtaken by a shower, which, moistening their wings, stops their further flight, and at the same time accomplishes its final purpose by immediately promoting the germination of each seed in the moist earth? How little are children aware as they blow away the seeds of the dandelion, or stick burs in sport upon each other's clothes, that they are fulfilling one of the great ends in nature?' The ocean itself serves to waft the larger kinds of seeds from their native soil to far distant shores. While in ordinary cases, also, plants drop and disperse their seeds in dry weather only,—which is just the kind of weather most favourable to its success, for the seed, according to the farmer's adage, 'loves a dry bed,'—there are some plants, natives of arid deserts, which act according to a different economy. Thus, the cup of one plant of the desert has springs to close in dry weather, and to open only in the coming of moisture. Thus, also, the seed-vessel of the rose of Jericho is rolled by the winds along the wilderness until it meets with a moist spot, and then, but not till then, it opens and parts with its seed. How wonderful all this arrangement and contrivance! Here is not the foot print of blind chance, but the finger of God."

Seeds which have lost their vitality through age or bad keeping are sometimes doctored by chemical appliances, and brought into the market under the name and with the appearance of perfectly fresh seeds. A report upon enquiries into adulterations by a Committee of the House of Commons, a good number of years ago, stated that the "old seed of white clover was doctored by first wetting it slightly, and then drying it with fumes of burning sulphur, and that red clover-seed had its colour improved by shaking it in a sack with a small quantity of indigo; but this being detected after a time, the doctors then used a preparation of logwood, fined by a little copperas, and sometimes by verdigris, — thus at once improving the appearance of the old seed, and diminishing, if not destroying, its vegetative power, already enfeebled by age. Supposing that no injury had resulted to good seed so prepared, it was proved that, from the improved appearance, its market price would be enhanced by this process from 5s. to 25s. a hundred weight. But the greatest evil arose from the circumstance of these processes rendering old and worthless seed equal in appearance to the best. One wit-

ness tried some doctored seed, and found that not above 1 in 100 grew, and that those which did vegetate died away afterwards; whilst about 80 or 90 per cent. of good seed usually grows. The seed so treated was sold to retail dealers in the country, who of course endeavoured to purchase at the cheapest rate, and from them got into the hands of the farmers,—neither of these classes being at all capable of distinguishing the fraudulent from the genuine seed. Many cultivators in consequence diminished the consumption of the article; and others were obliged to pay a higher price to those who had skill to distinguish the mixed seed, and who had integrity and character to prevent them from dealing in it." Similar infamous adulterations, no doubt, are occasionally practised on other seeds; and as constitutional defects and diminutions of vigour and losses of vitality also occur from the operation of natural causes and from inadvertencies in treatment, farmers and gardeners ought never to risk a crop upon the sowing of seeds about which there can be the slightest doubt till they have first put them to the test. The colour of seeds, though a popular mark of goodness, is a very misleading one, and ought to be appreciated, never as any index whatever of vitality or vigour or other intrinsic properties, but merely as an adventitious enhancer of market value. The figure of a seed, in a certain degree, is a fixed character of species or variety, and yet, to a considerable extent, is determined by soil and climate,—insomuch that comparative sphericity is promoted by warm and early situations, and comparative elongation by cold and late ones. Large size, too, is generally owing to the soil,—yet is likewise a sign of ripeness. All seeds of home-growth set apart for sowing ought to be the ripest individuals of the most vigorous plants, and may easily be obtained free from admixture with the less ripe ones simply by slightly beating or lightly thrashing the plants.

Annual or biennial farm plants, when cropped through a series of times from seed grown on one field or on fields of one character as to soil and situation, are liable to degenerate somewhat analogously to domesticated animals who are bred in-and-in; and they experience corresponding invigoration from renewals of seed either by importation or by hybridizement. "Where domestic seed is relied on, it is proper to change the seed from the heavier to the lighter parts of the farm, and *vice versa*, if there be much difference. On clay farms, in general, domestic seed may be safely used for some time; but with a view to prevent degeneracy, it is an excellent practice to select from the growing crops the ears which are the soonest ripe, and which are of the plumpest quality; by this means, those husbandmen who devote themselves in a peculiar manner to this object can not only supply themselves, but can always command a much higher price than others, by selling the grain raised upon their farms for seed, either among their neighbours, or to be sent to other districts. A change of seed is in general to be recommended, as founded on rational principles. Every species of grain has a climate adapted to it, where it flourishes, where it grows to perfection, and where it never degenerates. In a country where wheat grows naturally, as in Sicily, seed dropping from the mother plant arrives at perfection, though neither the seed nor the soil be changed; but as wheat is not a native of Britain, it has here a great tendency to degenerate, more especially in the more northern districts,—and it degenerates rapidly if the seed be sown, year after year, where it was produced. Nor is it sufficient that the seed be taken from a different field; it ought also to be taken from a different soil, and from a different atmosphere. Farmers on the borders of Lincolnshire make a considerable advantage by purchasing their seed wheat from the Fens; and they find the change useful, and at the same time save in the price. In Flanders, they never use the grain or seeds grown on the lands to be sown, nor regard the additional expense attendant on the purchase of seed that is heavier and more healthy; their flax seed they bring from Riga or Memel, and their potatoes from Brabant. The Farming Society of Ireland, by its premiums, introduced the habit of sowing seed imported from England; and by this means the quality of the Irish grain is greatly improved, and the samples of corn now produced for sale at the Irish, would not disgrace any English market. Besides preventing a degeneracy in the quality of the grain, the crops of the farmer, by a judicious change of seed, will sooner reach maturity,—an object in many cases of the greatest moment. English grain, sown in Ireland, generally comes to maturity ten days, or even a fortnight, earlier than the native seed under similar circumstances. It is well known that a change of constitution in plants, originating from the situation in which they have been placed, is commonly transmitted to their offspring. Plants propagated from seed, produced in a warm sandy soil, will therefore grow fast in whatever soil the seed is sown; and plants from seed produced in a cold stiff soil, are late of growing, even in a warm soil. Hence the advantage of changing seed from a warm to a cold soil; for though seed from a warm soil will not grow so quickly in a cold soil as in a warm soil, it will, however, always grow more quickly than seed from a cold soil. The quantity also will be increased. From an experiment made by the celebrated Lord Kames, it would appear that the produce of changed seed exceeds that of old seed, at the rate of nearly 26 per cent. The farmer, however, ought not to alter his seed while it gives him fair and reasonable satisfaction, unless he has every reason to be convinced that better can be obtained by a change. It is proper to add, that in two cases it has been found expedient to change the seed from an inferior to a superior

climate. In Flanders, where great quantities of flax are grown, the seed must be brought from the Baltic; otherwise the crop will be deficient. In the case of potatoes, also, seed is imported from an inferior climate, as the most likely means of preventing the disease called the curl. Besides changing seed, crossing different varieties has been found of use. Mr. Knight not only raised new varieties of apples, and of the garden pea, but likewise tried experiments with crossing wheat, which he effected by sowing the different kinds together. This was attended with a most extraordinary result; for when, in the year 1796, almost the whole crops of corn in the island were blighted, the varieties obtained by crossing alone escaped, though sown in different soils and in very different situations."

The quantity of any kind of agricultural or horticultural seed sown ought to be controlled by considerations respecting the climate, the soil, the season, the weather, the mode of sowing, and the quality of the seed. In a climate of comparative unsteadiness and severity, which is liable to a succession of variable weather, or which is occasionally swept with great storms of rain or snow, or which is sometimes visited with unseasonable frosts or with great and sudden changes of temperature, a larger quantity of seed is requisite, were it merely to provide against accidental injuries and killings of the seed itself or of the young plants rising from it, than in a climate of comparative repose and mildness. On thin light soils, which are favourable to tillering, and yet contain comparatively little sustenance for plants, and are unable to produce very luxuriant crops, considerably less seed is proper than on strong, stiff, retentive soils, which are unfavourable to tillering, and yet contain comparatively large stores of nourishment, and are well able to support the most abundant crops. But when even strong clay lands have been thoroughly under-drained, and are in high condition, and have been rendered friable and mellow by assiduous tillage and fallowing, they require as little seed as light lands, and sometimes even less. Though a sparcely sown crop of wheat, on such soils, may appear thin during winter, the seedling plants have time and vigour enough to fill up the field by means of tillering, and will be found to produce a full crop in autumn. When sown too thick, rich fields are apt to become overstocked with more plants than can come to perfection; and these accordingly grow up weak, slender, and unproductive. Less seed is required by summer fallowed land than by bean stubble, and less by bean stubble than by clover lea, and less by clover lea than by turnip land sown in spring. Seed sown at a comparatively remote period from the time of ripening gives the crop more scope for tillering and ampler power to overcome retardations and resistances from adverse weather, than seed sown at a later period, and therefore ought to be correspondingly less in quantity. When the season is very dry, and occasions great paucity of moisture in the soil at the time of sowing, more seed may fail to vegetate than in other circumstances, and therefore proportionally more ought to be sown. Less seed is proper in the dibbling method of sowing than in the drill method, less in the drill method than in the broadcast method, and very much less in commixation with another seed for an accompanying crop than when sown alone and intended to occupy the whole ground. Less quantity, too, is required of perfectly sound seed than of merely mediumly good seed, less of mediumly good seed than of very doubtful or decidedly bad seed, less of round, plump, large seed than of longish, slender, and comparatively bad seed, and less of seed which is well fortified by preparatory processes for resisting the attacks of insects and fungi and unfavourable weather than of seed of the same quality which is either not at all or very inadequately fortified by such processes. See the article Sowing.

The preparing of seeds comprises processes for detecting and separating unsound grains,—processes for accelerating germination or promoting earliness of growth after sowing,—processes for protecting the seeds against the attacks of vermin, grubs, and parasites,—and processes for augmenting the nutrimental resources of the seeds, and enabling them either to dispense, in some degree, with the aid of manures in the soil, or to use up the manures with a more luxuriant and productive account. One of the simplest of these processes is noticed in the article Brining; and some of the most peculiar are mentioned in the articles on the several plants or crops to which they apply.

The detecting and separating of unsound grains can, in most instances, be readily accomplished by merely pouring the seeds gently into common water or into a weak solution of salt and water, —and, if necessary, slightly stirring the water or solution till all the grains have an opportunity of becoming immersed or wetted; for the sound grains will sink to the bottom and remain there, and the unsound ones will either swim from the first on the surface or will readily rise with aslight stirring, and may easily be skimmed off.

The accelerating of the germination of seeds is generally effected by artificial applications of heat and moisture during some hours or days immediately before the intended time of sowing. A common method is simply to steep the larger and clean-skinned seeds, such as beans and barley, in pure water, and to immerse the smaller and rougher seeds, such as those of carrots, in a little well-moistened soil, and to keep it in a warmish place, and turn it occasionally over. But all such processes, especially in the case of the former class of seeds, require to be conducted with judgment and caution and a wise regard to time and temperature; for, if otherwise conducted,

they may either enfeeble the seeds or absolutely destroy their enclosed embryos.

The preserving of seeds from the attacks of insects, field-mice, birds, and other depredators, is effected principally by steeps or other applications of whale oil, stale urine, or any other substance which, while not injuring the seeds, will long continue to emit an offensive odour. The Romans of ancient times used, for this purpose, the lees of oil, decoctions of cypress leaves, the juice of house-leeks, and some similar substances; and the British and Continental farmers of the present day, in the case at least of wheat and barley and oat seeds, extensively use saline and caustic applications.

The enriching of seeds with such coatings or saturations as shall produce similar effects to doses of suitable manure, is effected, in some instances, by processes which, at the same time, protect the seeds from grubs and fungi and unfavourable atmospheric influences. "Public attention," remarked Professor Johnston in 1844, "has lately been drawn in this country to the possibility of so manuring or otherwise doctoring the seeds of our usual grain crops, before they are put into the ground, as to do away with the necessity of manuring the soil itself. It has been long known to practical farmers that, by steeping their seeds in urine, in salt and water, or in other solutions, and sprinkling them while wet with quicklime, their growth is in many cases promoted, and the rust, smut, and similar diseases, in a great degree prevented. It has been observed also in regard to potatoes, that in some soils a dusting of lime makes the cuttings more productive than they would otherwise be, and that, when powdered with gypsum, they thrive still better. The absolute effect indeed of all such applications to the seed corn or to potatoes, will in every case be modified by the kind of soil in which the seed is sown. If the soil abound in common salt, the salting of the seed will be less efficacious, while if it be rich in lime or in gypsum, the dusting of the potatoes with these substances will produce a less striking effect. Yet the above observations of practical men show that it is possible in certain circumstances, and by the use of certain substances, so to doctor or manure the seed we intend to sow, as to make the growth of our crop more sure, and the return of our harvests more abundant."

Some remarkable results, in this way, have already been obtained. Mr. Dalziell of Holm of Drumlanrig, four or five years ago, steeped seed-barley in diluted sulphuric acid, and found the crop from it better in all the stages of growth, and productive of eight bushels of grain more per acre, than a corresponding crop from unsteeped seed. Tinzmann of Silesia, according to a report of experiments made to a meeting of agriculturists at Munich in 1844, found that the steeping of seed-barley, during six hours, in a dilution of sulphuric or muriatic acid, at the rate of about 5 lb. of acid per acre in 40 times its own weight of water, gave one-fourth more straw and grain than unsteeped seed,—that a similar dilution and quantity of acid sprinkled over the ground before sowing, gave very little increase,—that steeping in pure water gave more straw than unsteeped seed, but a very slight increase of grain,—and that the steeping of wheat-seed, oat-seed, vetch-seed, turnip-seed, and grass-seeds in a dilution of muriatic but especially of sulphuric acid, gave more or less increase,—but that the acid must be used with caution, and sometimes diluted to a greater degree than in 40 times its weight of water, and that the success of the steeping is greatest in soils which have long been in good cultivation, and may not always be observable on poor exhausted soils. Mr. James Campbell of Dundee, according to a communication which he made to the Highland Society in 1843, found that extraordinary vigour and productiveness in corn and herbage plants were obtained by steeping their seeds in single or mixed solutions of nitrate of soda, nitrate of potash, nitrate of ammonia, muriate of ammonia, and sulphate of ammonia,—that the various mixtures should consist of the salts exactly neutralized, and dissolved, in from 8 to 12 measures of water,—and that the duration of the steeping did best at from 8 to 10 hours with clover seeds, from 16 to 20 hours with gramineous seeds, and from 50 to 90 hours with corn seeds, yet not more than 60 with barley seeds; and he afterwards offered his preparations, under the name of "corn-growing liquids," for sale, and received considerable corroboration of the published results of his experiments from careful trials on the part of some distinguished agriculturists. M. Victor of Neiderholm, in Hesse Darmstadt, according to a pamphlet published by him in 1843, found, from experiments conducted during five years, that corn plants acquired extraordinary vigour and productiveness, and at the same time escaped rust and other diseases, in consequence of first immersing the seeds in a semi-fluid mass of blood, oil, salt or sal ammoniac, powdered clay, linseed meal and water, and then so spreading them upon drying mixtures as to cause them to be coated with the preparation. Another German experimentalist, Franz Heinrich Bickes, published in the same year a professed discovery of a method of so steeping or otherwise preparing all sorts of field and garden seeds as to cultivate the soil without the aid of manure; and many other persons of late years, in Britain but especially in Germany, have thought, in various ways, of fertilizing soils or invigorating crops by means of steeping seeds.

Unhappily, most of the advocates of the new theory drive it to the length of extravagance or absurdity; and are not content to regard their respective methods of preparing seeds as simple or even important aids to fertility, but insist on their being complete substitutes for all manure, or even agencies of far superior power to

the combined action of both soil and manure. Mr. Campbell, for example, says, "From the experiments which I have already tried, I am quite satisfied that, even without the application of common manures, double crops at least may thus be raised, and under the application of the ordinary manures crops tenfold greater than usual;" and Mr. Bickes says, "The discovery of cultivating the soil without manure has been carefully verified in different countries and in the most dissimilar soils. It is not the discovery of a mere crude substitute for manure, but rests on a knowledge of the nature of plants, by which the vital power is increased in all respects, and their existence elevated and ennobled. Who can assign limits to the growth of a plant? I possess dried plants of wheat, consisting of 56 and 57 stalks; Indian corn, grown in a poor soil, with 3 or 4 stems and 8 or 9 heads; sunflowers 11 feet high, with flower disks 14 inches in diameter, and seeds as large as small coffee beans; potatoes above 7 feet high, and tubers in proportion. Drift sands have produced crops equal in quality to the neighbouring loams. Agriculture can now be prosecuted after an entirely new method. Manured every year almost without cost, plants will develope themselves almost spontaneously, and yield the largest returns." Wild assertions like these do enormous harm by deterring cautious ill-informed farmers from listening to the theories and speculations of scientific agriculturists, and by inducing sanguine, unreflecting, would-be-learned ones to waste their time and money in quixotic experiments, to the neglect of sober methods of improvement; and though they have, in the present instance, attracted great attention and drawn out a large degree of both blind opposition and credulous confidence, and though too they suggest enough of truth to point out new and very promising methods of investigation, they are, at the same time, so recklessly absurd as to deserve no small measure of pity or contempt. A plant can no more grow without food in the soil than a foal or an infant can grow without food received into the stomach; and a seed cannot possibly acquire any increase of its functional powers except by means which shall either protect it from morbific or debilitating influences, or enrich it with additions to its intrinsic stores of nourishment, or excite and strengthen it to take up additional supplies of food either from the soil and the atmosphere or from artificial deposits of manure.

The real conditions under which seeds can be fertilizingly benefited by any doctoring processes, and the true principles on which the invention of the best of such processes should be attempted, were well-stated, in the following terms, in 1846, by Professor Johnston: "When barley is steeped for the purpose of malting, the water, which is several times renewed, extracts from it a considerable proportion both of organic and of inorganic matter. The inorganic part of the extract is rich in alkaline matter and in phosphates, all of which must be lost to the seed, and yet it sprouts well in the hands of the malster notwithstanding. Is the saline matter which the grain thus loses necessary to its healthy or perfect condition? Is it necessary to its growth in ordinary soils? Is it a provision of nature by which a store of these substances is laid up in the seed above what is required for its own perfect development, with the view of meeting the emergency of its being placed in a soil in which these substances are unusually deficient? Or are we to consider as only accidentally present the saline and other compounds which are thus easily extracted from it by simple steeping in water? These are interesting questions, especially to the chemical physiologist; and it would be very interesting to solve them. If the seeds sprout and the plants grow as well, and yield as good a crop on all soils, after these salts are extracted by water, as when the unsteeped seed is sown, or seed steeped only in so much water as it can absorb, then we may infer that what the water extracts is not necessary, and that the seed would perform all its natural functions as well without their presence. In that case we should be justified in concluding that they formed no part of the necessary and natural constitution of a healthy seed.—But if, on the other hand, the seed thus exhausted by water grows less vigorously and yields a small return, then we should be justified in concluding, not only that these saline matters which water extracts are really necessary to the perfection of the seed, but in inquiring whether the seed might not with advantage be provided with a larger portion—be beneficially steeped, that is, in a solution which would still further charge it with these saline substances, before it was committed to the soil. The answer to this inquiry would be obtained by steeping the grain in a solution containing the same or similar substances to those naturally present in the perfect seed. Such a steep would be obtained by the use of a mixture consisting of phosphate of soda, sulphate of magnesia, nitrate of potash, common salt, and sulphate of ammonia. One pound of each of these substances dissolved in 10 gallons of water, will be sufficient to steep 300 lbs. of seed, which may remain in the solution from 30 to 50 hours, and should be afterwards dried with gypsum or quick lime. The quantity of saline matter above prescribed is sufficient to impregnate the grain with an additional portion equal to that which it naturally contains.—It is possible that after the grain has been extracted by water, it may again be impregnated beneficially with an artificial saline solution, such as that above described, or by a solution of one of the substances only of which the mixture is composed—of nitrate or phosphate of soda, for example, or of sulphate of soda. Most of these experiments bear more or less directly upon practical opera

tions, but they are especially interesting to the physiologist. I would, therefore, venture to suggest that advantage might be derived, and considerable knowledge obtained, by the careful performance of such a series of experiments as the following upon the steeping of barley:—Seed steeped and washed in repeated waters; steeped in as much water only as it can absorb; steeped in diluted sulphuric acid; steeped in diluted muriatic acid; steeped in mixed saline solutions as above; steeped first in water and then again in the mixed saline solution; steeped in nitrate or phosphate of soda; steeped first in water and then in nitrate or phosphate of soda."

SEED-BASKET. See Rusky.

SEED-CORN. See Agricultural Seeds.

SEEDLING. A young plant which has not been removed from the seed-bed; also a plant of any given species raised from seed, as distinguished from one raised in any of the methods which do not originate varieties, or which do not renovate an old stock.

SEED-LIP. A basket in which a sower carries seed-corn during the process of broadcast field sowing.

SEED-SIFTER. See Sieve.

SEEL. The season or suitable time for any agricultural operation. Barley-seel, for example, is the season for sowing barley; hay-seel is the season of hay-making; and bark-seel is the season for barking trees. But the word, in all its uses, is provincial.

SEELING. The commencement of the appearance of white hair in a horse's eye-brows. This usually occurs between the 14th and the 16th year of a horse's age, and is therefore a mark of his becoming old.

SEG. A castrated bull. The word is provincial.

SEGGING. See Oat.

SEGS. The provincial name of sedges or carices. See the article Carex.

SELAGO. A genus of ornamental greenhouse plants, of the verbena family. About 20 species have been introduced to Britain from South Africa; and about as many more are known. Most of the introduced species are evergreen undershrubs of from 8 or 10 inches to 3 feet in height, carrying either white, blue, violet, or purple flowers, and propagable from cuttings; and all love a soil of peaty loam.

SELF-HEAL,—botanically *Prunella*. A genus of hardy herbaceous plants, of the labiate order. One species grows wild in Britain; and 12 or 13 species,—chiefly annual-stemmed perennials, of about 6 inches in height, carrying white or yellow or pink or blue or purple flowers in the latter part of summer and the early part of autumn—have been introduced from Continental Europe and North America. Most love a soil of peaty loam, and are propagated by division of the roots.

The indigenous or common self-heal, *Prunella vulgaris*, is the most interesting species, and may serve as a sufficient specimen of the whole genus. It inhabits the meadows and pastures of most parts of Britain, and is frequently found among clover. Its root is fibrous; several quadrangular, leafy stems rise from each root, and commonly attain a height of from 5 to 9 inches; the leaves are stalked and opposite, and have a brownish colour, and are entire, ovate-oblong, and about $1\frac{1}{2}$ inch long and $\frac{3}{4}$ of an inch broad; and the flowers are numerous, and grow in dense, solitary, erect, whorled spikes, and have either a white, a blue, or a purplish colour, and bloom in July and August. Two ornamental varieties, the one red-flowered and handsome, and the other double-flowered and curious, occur in gardens. This plant was formerly in repute as a vulnerary herb, and for the cure of a disease in the jaws and throat; but it has not now any recognised place in the materia medica. It somewhat readily finds its way among clover in consequence of its seeds ripening at the same time as those of that plant, and considerably resembling them; yet the seeds of self-seal may quite easily be distinguished by any ordinary observer from their being rather larger than clover-seeds and kidney-shaped.

SELENIUM. An elementary substance of an intermediate character between the metals and the simple non-metallic bodies. It is very scarce, and occurs for the most part in combination with sulphur. It is a brittle, opaque, tasteless, odourless body, of metallic lustre and lead-like appearance; but assumes a deep red colour when reduced to powder, softens into remarkable tenacity at a temperature of 212°, melts at a little higher temperature, and boils and evaporates with high yellow-coloured vapour at 650°. It greatly resembles sulphur in many of its properties and in the general character of its affinities or combinations. Some of the chief compounds of it are oxide of selenium, selenious acid, selenic acid, and seleniuretted hydrogen.

SELINUM. See Milk-Parsley.

SELLANDERS. See Mallenders and Sallenders.

SEMBRADOR. One of the earliest invented drill-sowing machines. It was invented by the Spaniard Don Joseph de Lucatello, and brought early to the notice of Britons through the Philosophical Transactions. It was fastened to the tail of the plough, and it dropped the seeds of corn-crops regularly into the furrow, and effected the sowing of any given area with about one-fifth of the seeds which were usually employed in hand-sowing; but it was not found to answer in common practice, and is now on record as a mere agricultural curiosity. See the article Sowing-Machines.

SEMICARPUS. See Cashew-Nut.

SEMINARY. A piece of ground allotted for raising perennial plants from seed, and keeping them till they become fit for removal into the

nursery or the garden. The word, as all Britons know, is also used metaphorically in the sense of a school.—the seed-bed of knowledge.

SEMPERVIVUM. See HOUSELEEK.

SENEBIERA. See WART-CRESS.

SENECILLIS. A small genus of ornamental herbaceous plants, of the jacobea division of the composite order. It comprises a yellow-flowered, annual-stemmed, hardy species, *S. glauca*,—and a purple-flowered, evergreen, slightly tender species, *S. purpurata*,—which Linnæus classed as cinerarias.

SENECIO. See GROUNDSEL.

SENEKA-ROOT. See MILKWORT.

SENNA. A well-known cathartic, consisting of the leaves of any one or two of several species of cassia. The most common senna plant is *Cassia italica*,—often called, by way of eminence, *Cassia senna*. This is a native of Upper Egypt, Nubia, and Benou; and furnishes a large portion of the senna of commerce. Its root is annual, its stem is erect, branching, and about two feet high; its leaves are pinnate, and comprise each five or six pairs of sessile, oval, pointed, yellowish-green leaflets, each scarcely an inch long, and rather more than a fourth of an inch broad; its flowers are produced in loose auxiliary spikes, and have a yellow colour, and bloom in June and July; and its legumes are ovate, kidney-shaped, membranous, leafy, and compressed, each having six or nine cells and containing the same number of oblong heart-shaped seeds. Another senna plant is *Cassia obovata;* and this also is sometimes called, by way of eminence, *Cassia senna*. It is a native of Upper Egypt, and was introduced to Britain before the middle of the 17th century. Its root is annual; its stem is about 20 inches high; and its flowers are yellow, and bloom in July and August. The leaves of this species are less purgative than those of *Cassia italica*, and constitute a considerable portion of the senna of commerce, but are generally mixed, even at the first native market, with those of *Cassia angustifolia* and those of *Cynanchum oleifolium*,—the former as good or nearly so as themselves, but the latter a downright adulteration.—A third senna plant is *Cassia lanceolata*. This is an evergreen undershrub of about a foot in height, and carries yellow flowers in July and August. It is a native of the Levant, and was long ago cultivated in Arabia, and is now cultivated on the coast of Malabar. The produce of it is somewhat extensively imported from Calcutta, and bears the name of East India senna.

Senna leaves emit a faint and somewhat disagreeable and sickening odour, and have a sweetish, slightly bitter, nauseous, aromatic taste. An infusion of them has a deep reddish brown colour, and possesses both their odour and their taste. Their active principle is a peculiar substance called cathartin. See the article CATHARTIN. Senna is a sure and comparatively mild purgative; but is liable to gripe, and requires to be accompanied with some aromatic. Decoction is a bad form of preparing it; but both the infusion and the powder are good; and in some cases, the tincture, the syrup, and the electuary are suitable.

SENSITIVE PLANT. Any one of several species of the genus mimosa,—though the name is most commonly given to the pink-flowered Brazilian biennial, *Mimosa sensitiva*. See the articles MIMOSA and IRRITABILITY. "The movement of the leaves of the *Mimosa pudica*," says Mr. C. Mackenzie, "have their origin in certain enlargements, situated at the articulation of the leaflets with the petiole, and of the petiole with the stem. Those only which are situated in the last articulation are of sufficient size to be submitted to experiment. If, by a longitudinal section, the lower half of this swelling be removed, the petiole will remain depressed, having lost the power of elevating itself. If the superior half be removed, the petiole will remain constantly elevated, having lost the power of depressing itself. These facts prove that the motions of the petiole depend on the alternate turgescence of the upper and lower half of the enlargement, situated at the point of articulation; and that contractibility is not the principle of these motions. If one part of the plant be irritated, the others will soon sympathise, or bear witness, by the successive falling of their leaves, that they have successively felt the irritation. Thus, if a leaflet be burnt slightly by a lens, the interior movement which is produced will be propagated successively to the other leaflets of the leaf, and thence to the other leaves on the same stalk. M. Dutrochet found that this interior movement is transmitted equally well, either ascending or descending; that it is equally well transmitted, even though a ring of bark has been removed; that it is transmissable, even though the bark and pith be removed, so that nothing remain to communicate between the two parts of the skin, except the woody fibres and vessels; that it is transmissable, even when the two parts communicate merely by a shred of bark; and that it may be transmitted, even when the communication exists by the pith only; but that it is not transmissable, when the communication exists merely by the cortical parenchyma. From these very interesting experiments, it results that the interior movement produced by irritation, is propagated by the ligneous fibres and the vessels. The propagation is more rapid in the petioles than in the body of the stem. In the former, it moves through a distance of from three to six tenths of an inch in a second; in the latter, through from eight to twelve hundredths of an inch, during the same portion of time. External temperature does not appear to exert any influence on the rapidity of the movement, but very sensibly affects its extent. Absence of light, during a certain time, completely destroys the irritability of the plant.

Such change takes place more rapidly when the temperature is elevated, than when it is low. The return of the sun's influence readily restores the plant to its irritable state. It appears, therefore, that it is by the action of light that the vital properties of vegetables are supported, as it is by the action of oxygen that those of animals are preserved; consequently, etiolation is to the former what asphyxia is to the latter."

SEPTAS. A genus of curious, evergreen, white-flowered, South-African, herbaceous plants, of the houseleek family. Three species, varying in the height of the flower-stem from 4 to 10 inches, have been introduced to the greenhouses of Britain; and they love a soil of sandy peat, and are propagated by division of the root. The name septas alludes to the curious fact that all parts of the flower are divided into seven.

SEPTEMBER. See CALENDAR.

SEPTFOIL,—botanically *Tormentilla*. A small genus of indigenous, perennial-rooted, herbaceous plants, of the rosaceous order.

The erect or officinal species, *T. erecta*, or *T. officinalis*, abounds in the heaths and coarse dry pastures of many parts of Britain. Its root is knotty and woody; its stems are erect, cylindrical, leafy, branched, diffuse or procumbent, and commonly about a foot high; its leaves are almost sessile, ternate, lanceolate, serrated, and hairy, and are accompanied with deeply incised stipules; its flowers stand on long, opposite, solitary, one-flowered footstalks, and have a golden yellow colour, and bloom from May till October; and its seeds are few and wrinkled. The root has powerfully astringent properties, and is a common and valuable remedy for intermittents and especially for diarrhœas and chronic purgings. It is used also, though not often, as a gargle or lotion for ulceration of the tongue and mouth, and as a local application to fetid and refractory sores. It is blackish without and reddish within, and has a slightly aromatic odour and an austere styptic taste, and yields all its active principles to boiling water. A dwarfish double-flowered variety of the plant, *T. e. flore-pleno*, occurs in some parts of Wales, but is rare.

The creeping or trailing septfoil, *T. reptans*, occurs about hedges and the borders of fields, and in some meadows and pastures, in various parts of Britain. Its stems are hairy and about two feet long, and have a prostrate but not creeping mode of growth; its stipules are undivided; its leaves stand on long hairy footstalks, and have each five leaflets, obovate, strongly serrated, and bright green; and its flowers are twice as large as those of the erect species, and have a full yellow colour, and bloom in June and July. This species also possesses astringent properties, but not in a sufficient degree to entitle it to a place in the Materia Medica.

SEPTUM. A partition in the interior or between the parts of any organism.

SERAPIAS. A small genus of curious, tuberous-rooted, brown-flowered, greenhouse, herbaceous plants of the orchis order. See the article ORCHIS.

SEROUS FLUIDS. Animal liquids of a whey-like appearance. Whey itself is the chief or normal serous fluid, or simply serum, and will be found noticed in our articles WHEY and MILK. The serum of blood is the thin liquid which separates during coagulation; and it has a yellowish colour, a slightly saline taste, a somewhat unctuous touch, and an average specific gravity of about 1·029, and possesses a slight alkalinity, and consists, according to Marcet, of 90 per cent. of water, 8·68 of albumen, 0·66 of muriate of potash and soda, 0·165 of carbonate of soda, 0·035 of sulphate of potash, 0·06 of earthy phosphates, and 0·4 of muco-extractive matter. The serous liquid secreted by the pleura, the pericardium, the peritoneum, and other serous membranes of the animal system, consists, according to Bostock, of 92 per cent. of water, 5·5 of albumen, 0·5 of muriate of soda, and 2 of mucus. The serous liquid which surrounds a fœtus, or what is often called the liquor of the amnios, differs in composition in different animals, and contains a peculiar acid in the cow.

SERRATED LEAF. A leaf whose edges are notched or indented in the manner of a saw.

SERRATULA. See SAW-WORT.

SERRURIA. A genus of ornamental, evergreen, Cape-of-Good-Hope shrubs, of the protea family. About 40 species have been introduced to the greenhouses and conservatories of Britain; and a number more are known. The introduced species vary in height from 1 foot to 8 feet; and most have purple flowers; and some require to be raised from seeds, though others are propagable from cuttings. The soil suitable for most is either a sandy or a peaty loam.

SERUM. See SEROUS FLUIDS.

SERVICE-TREE. Several species of rosaceous-flowered trees, of the pyrus or pear genus. They formerly were regarded as constituting a separate genus under the name of Sorbus.

The sweet or true service-tree, *Pyrus sorbus*—called by Linnæus *Sorbus domestica*—is a rare and somewhat doubtful indigen of moist woods in some parts of England, and probably was long ago introduced from the South of Europe. It presents a somewhat close resemblance to the mountain-ash, but is larger and more valuable. Its stem is upright, and commonly attains a height of about 30 feet; its young shoots have a downy or mealy appearance in summer, but incline toward a purplish colour, spotted all over with whitish spots, in winter; its buds, at the extremity of the shoots in winter, are turgid; its leaves are finely pinnated, and comprise seven or eight pairs of leaflets and a terminating odd one, and are broader and larger than those of the mountain-ash, and are more deeply and irregularly serrated, and have a much more downy under-surface; its flowers are white, and grow

in umbels, and bloom in May and June; and its fruit are large and fleshy, and have different shapes in the different varieties. This species takes the name of sweet or true service on account of the edibleness of its fruit; and it ranks as a dessert fruit-tree in France and Italy and some other parts of the Continent; but it has poor and scanty reputation as a fruit-tree in Britain. Its trees are slow in growth, and not early bearers; and require, for fruiting purposes, to be raised from layers,—and these make roots very tardily, and must remain at least two years in attachment to the parent-tree before they become fit for removal. Plants raised from seeds very rarely come true to the parental characters. The pear-shaped variety is the kind cultivated in orchards; and the fruit of it grows on the point of the branches, and requires, when gathered, to be laid in the fruit-room till the pulp passes into a state of decay; and it then has a comparatively mild acid taste, yet is seldom relished so much by Britons as the medlar.

The wild or griping service-tree, *Pyrus torminalis*—called by Linnæus *Cratægus torminalis*—grows wild in the woods and hedge-rows of several parts of England. Its stem commonly attains a height of about 50 feet; its growth is slow; its wood is hard; its leaves stand on long stalks, and are simple, seven-lobed, somewhat heart-shaped, serrated, and dark green; its flowers are white and numerous, and grow in large, terminal, downy, corymbose panicles, and bloom in April and May; and its fruit is umbilicated and not larger than that of the hawthorn, and becomes edible and agreeably acid when touched with frost or when partially decayed.

The mongrel or pinnatifid service-tree, *Pyrus pinnatifida*—called by Linnæus *Sorbus hybrida*—grows wild on rocky ground in some parts of England. It attains a height of about 40 feet, and is useful as a timber tree. Its stem is erect; its young branches are whitish; its leaves are very downy; and its flowers are white, and grow in umbels, and bloom in May and June.—Three other species of pyrus were comprised in the old sorbus genus, and may therefore be regarded as, in a sense, service-trees,—the common mountain-ash, the intermediate pyrus, and the small-fruited pyrus.

SESAMUM. See Oily Grain.

SESBANIA. A genus of ornamental, tropical, yellow-flowered plants, of the lotus division of the leguminous order. Two evergreen shrubs of about 4 feet in height, one biennial of about 6 feet in height, and 9 or 10 annuals of from 2 to 4 feet in height, have been introduced to the hothouse collections of Britain; and all bloom in July and August, and thrive in either common soil or a mixture of peat and loam, and are propagated from seeds. The oldest-known kinds were viewed by old gardeners as a sort of bastard sensitive plants.

SESELI. See Meadow-Saxifrage.

SESLERIA. A genus of grasses of the cynosurus tribe. The blue species, *S. cærulea*, grows wild in the moist, calcareous, rocky, upland fields and pastures of Britain. Its root is perennial, long, and strong, and forms dense tufts; its culms are smooth, simple, principally naked, and from 4 to 15 inches high; its leaves are linear, rather obtuse, keeled, and of a colour between sea-green and bluish; and its spikes are ovate, oblong, imbricated, about an inch long, and of a leaden colour sometimes inclining to purple, and have short, alternate, notched or jagged bracts, and bloom from April till June. This grass has an elegant and singular appearance, and is interesting to the botanist, but ranks only as a weed in the classification of the farmer. Seven or eight hardy, perennial species, varying in height from 3 to 20 inches, have been introduced to Britain from various parts of Continental Europe; but though some are ornamental, none possess any agricultural interest.

SESUVIUM. A genus of ornamental, tropical, herbaceous, red and white flowered plants, of the order Ficoideæ. Two annual species, and three perennial ones, varying in height from 1 foot to 3 feet, and all blooming in the latter part of summer, have been introduced to the hothouses of Britain from South America and the two Indias. The sessile-flowered species, *S. sessile* or *S. portulacastrum*, one of the perennials from the West Indies, 3 feet in height, and a herbaceous evergreen, contains a large quantity of saline matter, and is an excellent substitute for summer spinach.

SETARIA. A genus of grasses of the panicum tribe. Its species differ from the true panicums principally in having their panicles so contracted as to resemble spikes. Two species of economical interest and agricultural value are noticed in the article Millet. The green and the whorled species, *S. viridis* and *S. verticillata*, are annual indigens of respectively the sandy and the moist fields of some parts of England, and have a height of about 20 inches, and bloom in July and August. Upwards of 20 species, principally hardy annuals, have been introduced to Britain from various and widely-distant parts of the world; but all, as well as the true indigenous species, rank in the farmer's vocabulary as mere weeds.

SETON. A skein of thread or a piece of coarse tape looped through the skin of a horse or an ox, to act as a counter-irritant. It may be of any size or thickness, from very small to very bulky; and it admits of application to almost any part of the body. The tape is smeared or moistened with some digestive or stimulating unguent; and is passed beneath the skin by means of a strong flat needle; and ought to be secured at each end with a large knot of many ties or knots. Setons counteract inflammation in the same way as rowels, blisters, and cauteries; but they are the simplest and most manageable and most generally

applicable of counter-irritants, and can be used in situations and under circumstances where these other remedies are inadmissible. They are employed more commonly on the Continent than in Britain; but have of late years acquired increasing favour among British farriers. They serve particularly well in poll-evil, fistulous withers, and other ulcerative processes,—in chronic enlargement of the joints and ligaments and other parts,—and in all abscesses and diseases of the navicular region. In every case, a seton must be cleaned and moved daily, and dressed with common resin ointment; and in cases of their application to a sinuous track for the purpose of inflaming it, they must be renewed twice a-day, and moistened each time with oil of turpentine or tincture of aloes and benjamin or some similar stimulant.

SETTER. See Dog.

SEWERAGE. The drainage of towns. It comprises the rain water from the streets, the silty portions of mud from the yards and causeways, the foul water from kitchens, the refuse water of manufactories, the cleanings of water-closets, and, in general, all the filth and salts and organic matters which are not readily removeable in carts or waggons; and it is therefore very rich in at once variety, kind, and power of manurial ingredients. Even though it contained nothing more than nearly all the excrements, both liquid and solid, of the whole population, both brute and human, and though it held these in a state of very great dilution in otherwise useless water, it would be a highly valuable liquid manure; but it also contains other eminently fertilizing substances, and combines them and the excrements in proportions suited to the average wants of almost all field crops, and holds all in a state of comparatively great concentration,—and it is therefore well fitted to serve as a succedaneum for farm-yard manure, or rather, in fact, is in itself the very best of all general manures. The analysis of a specimen of it is given near the close of the article Manure; a good notion of its silty and least valuable portions may be obtained from the article Police Manure; a large instance of its tried power as a liquid manure for grass lands is mentioned in the article Irrigation; and striking ideas of the fertilizing energy of its most active and characteristic ingredients may be obtained from the articles Liquid Manure, Urine, Night Soil, Excrement, and Animal Manures.

A statement of the vast annual loss of manurial matters sustained by Britain, in several ways, but chiefly in the escape of sewerage to rivers and the sea, is made in the last section of our article Manure; and the following statement was made by a distinguished agricultural writer seven years ago, and has been abundantly borne out by more recent investigations respecting the condition of the metropolis:—"By carefully conducted experiments and very accurate gaugings, it has been found that the chief London sewers convey daily into the Thames about 115,000 tons of mixed drainage, consisting on an average computation, of 1 part of solid and 25 absolutely fluid matters; but if we only allow 1 part in 30 of this immense mass to be composed of solid substances, then we have the large quantity of more than 3,800 tons of solid manure daily poured into the river from London alone, consisting principally of excrements, soot, and the debris of the London streets, which is chiefly carbonate of lime; thus, allowing 20 tons of this manure as a dressing for an acre of ground, there is evidently a quantity of solid manure, annually poured into the river, equal to fertilizing more than 50,000 acres of the poorest cultivated land! The quantity of food thus lost to the country by this heedless waste of manure is enormous; for only allowing one crop of wheat to be raised on these 50,000 acres, that would be equal to the maintenance (calculating upon an average produce of 3 quarters of wheat per acre) of 150,000 persons. London, too, is only one huge instance of this thoughtless waste of the agricultural riches of the soil of England; from every other English city, every town, every hamlet, is hourly passing into the sea a proportionate waste of liquid manure; and I have only spoken of the solid or mechanically suspended matters of the average; the absolutely fluid portion is still rich in urine, ammoniacal salts, soda, &c., when all the mechanically suspended matters have been separated from the other portion. According to very careful experiments, this fluid part often contains 16 per cent. of animal matters, salts, &c., intimately or chemically combined with the water." The waste of sewerage, also, is a tremendous outspread of noxious exhalations and a dreadful polluting of useful streams, to the effect of marring the public comfort, injuring the public health, and constantly keeping up epidemics and pestilence; so that any measure which completely saves and economises sewerage for the purposes of manuring, at the same time acts as a mighty conservator of the life and well-being of both man and beast.

A great enterprise was recently commenced, by what is called the Metropolitan Sewerage Manure Company, for appropriating all the sewerage of London to manuring purposes; and this, it is to be hoped, will not only prove highly compensating to the parties interested in it, and eminently beneficial to the farmers and the market-gardeners who may avail themselves of it, but be speedily imitated in every city and considerable town of the empire. The whole plan is nearly a counterpart of that by which the city is supplied with water and with gas. Between the new house of Parliament and Stanley-bridge run two great sewers, the King's Scholars' Pond and the Ranelagh, both of them open, and some five or six small ones. The company makes an intercepting sewer from the first

of these to Stanley-bridge, of the capacity of 6 feet by 4¾. This sewer will run considerably deeper than either of the sewers it will intercept, and will be formed in the London clay, and completely covered in, so as to afford a perfect protection against the effluvia that proceed from the sewers as they now exist. Each sewer will be connected with the company's sewer by means of a shaft, with a shute, so that whenever they are not needed, the contents of the sewer may be sent through their former channel, and a grating at the mouth of the shaft will prevent the flowing in of solid substances. At Stanley-bridge this intersecting sewer will find its terminus, and there will the works of the company be stationed. The machinery is extremely simple. At the extremity of the sewer will be a tank, or well, from which the contents will be pumped, by means of a steam-engine of considerable power, into pipes precisely similar to those used by the water companies for conveying clean water. These mains will run along the high road, with branch mains into the side roads, and thence on either side, by means of service pipes, will the sewerage water be distributed to all who may desire to avail themselves of it; still observing precisely the plan by which the water companies carry the clean water through the streets of London. And much in the same manner as they supply the very summits of our houses with these mains, does the Metropolitan Sewerage Manure Company propose to supply the gardens and farms that lie on either side of their mains; with this difference in favour of the latter, that they have not to force the water up to the tops of high houses, but only along fields that are level, or almost so. And thus far, at least, there is nothing experimental or doubtful or difficult in the plan. The only novelty lies in the proposed manner of distributing the sewerage water to the soil, after it is conveyed to the immediate neighbourhood of the garden or farm by the mains running along the roads; and even this is done somewhat in the mode of the service pipes for the distributing of gas. Suppose a market gardener to desire a supply; a pipe will pass from the main into his garden; and there will be placed a stand-pipe, similar to those erected in all the streets in London for the use of the water-carts. If his gardens be large, he can erect at a very trifling cost as many stand-pipes as convenience and the saving of labour in conveyance of the sewerage may require. Thence he will be enabled to take an unlimited supply, at all seasons and at all hours, of the most fertilizing manure in the world! But upon farms, and where extensive grounds are to be manured, a singularly simple contrivance is to be adopted, by which the sewerage will be thrown over the land at the most trifling cost for labour, and with an uniformity and apportionment of quantity to the requisites of the soil, at present unknown, and indeed impracticable. The simple means for effecting this is the hose-pipe now in universal use for fire-engines. This pipe is perfectly flexible, so that it can be carried over hedges or walls, and laid in any direction, and yet offering so little resistance to the fluid, that in an experiment made at the New River Head, with a pressure considerably less than that proposed for the company's works, after passing through half-a-mile of hose-pipe, the jet from the mouth was thirty feet, and so powerful that it would have knocked a man down at a distance of five yards. But a hose-pipe of a quarter of a mile in length will suffice for the purposes of any farm, for that would permit the stand-pipes to be placed half-a-mile apart. Thus, then, when a farmer desires to manure his farm thoroughly, he has only to fix the hose-pipe to the stand-pipe: the former, being perfectly flexible, will run over hedges or gates—up hill and down dale; and in the field required to be manured, nothing more will be necessary than for one man to take in his hand the end of the pipe, from which will flow a jet from twenty to thirty feet, and play it upon the soil as easily as he would a watering-pot upon a flower-bed. And in this manner will one man be enabled to manure two acres and a half per day with more ease, and with tenfold more efficiency, than, with the present methods, five men could manure the same area in four days. The saving in labour alone will be enormous. And the price, too, will be a great consideration; for the present price of manure in the neighbourhood of London, laid upon the field, but not spread, is about ten shillings per ton, and the coast of spreading it adds about sixpence per ton; but the company will be enabled to supply the sewerage at the price of sixpence per ton; and as one man will be enabled to manure two acres in a day, the total coast of the manure and the spreading will be only from sevenpence to eightpence per ton. Another important advantage is, that the sewerage manure will afford a supply of water during summer, and serve for occasional irrigation during droughts. There can, therefore, be no doubt that it will be eagerly taken by the farmers, but still more so by the market gardeners, who now pay as much as from £15 to £20 per acre for manure.

SEYMERIA. A genus of ornamental exotic plants, of the figwort family. Two hardy annual species, the fine-leaved and the pectinated, both about a foot high, and carrying yellow flowers in July and August, have been introduced to Britain from North America.

SHACK. Waste corn left in the fields; also, live stock feeding on stubble land; also, land in an unenclosed state similar to that of a common. But the word, in all the senses, is provincial.

SHADDOCK,—botanically *Citrus Decumana*. A tropical evergreen fruit-tree, of the orange genus. It is a native of India, and was introduced thence to the orangeries of Britain in 1724; but it has long been naturalised and ex-

tensively cultivated in the West Indies, and is often regarded as a characteristic fruit-tree of that region. Its stem commonly rises to the height of about 15 feet; its leaves are ovate-lanceolate, thick, and shining; its flowers are white, and bloom from May till July; and its fruit is comparatively large, and possesses cooling and aperient properties, and has a taste somewhat similar to that of a fine orange, and, when of prime quality, is one of the most exquisite fruits in the world. But after the plant came to be generally grown in the West Indies, it greatly degenerated in consequence of bad culture, and of want of care to propagate fine varieties by budding. The fruit of good trees has red flesh and a luscious flavour; but that of most of the West Indian trees has pale yellow flesh and a harsh sour taste. The proper management of the shaddock-tree is similar to that of the orange-tree.

SHAKE. A disease in trees, consisting of long splits up the stem, and caused, in many instances, by violently bending the trees when young.

SHALE. See Soil, Marl, Clay, and Coal.

SHALLOT, Escalot, or Eschallot, — botanically *Allium Ascalonicum.* A hardy, perennial, bulbous-rooted, culinary plant, of the onion genus. It was introduced to Britain from Palestine about the middle of the 16th century. Its root is composed of a cluster of oblong bulbs; and is the part for which the plant is cultivated; and is used raw in salads, and cut small for sauce to boiled or fried meat. It has a stronger taste than the onion, yet is thought not to leave so strong an odour on the palate, and is therefore sometimes preferred to it. Each offset of the root, when properly planted and cultivated, becomes an independent luxuriant plant. The planting may be done either in October or November, or in February, March, or the beginning of April, at distances of 6 inches every way, in beds not more than 4 feet wide. In dry soil autumn planting is best; but in soil even moderately moist, spring planting is necessary, as the sets are very liable to be destroyed by moisture in winter. The time for taking up the bulbs is July or August. The flower-stem of the shallot-plant is about 10 inches high; and the flowers have a purple colour, and naturally bloom in June and July.

SHAMROCK. The national emblem of Ireland. It is commonly supposed to have been selected by St. Patrick as an emblematic illustration of the doctrine of the Trinity; it is inferred, from the taste and scholarship of St. Patrick, to be a plant of much elegance and beauty; it is known, from notices of it in old Irish writers, to possess a sour taste and to have been generally eaten by the ancient inhabitants of Ireland; and it has, for centuries, been most in request at the festival of St. Patrick in the month of March, and may therefore be supposed to have originally been in all its glory at that season of the year. What particular plant, then, is it? The word shamrock itself is merely a general Irish name for a trefoil, and gives no information. Common modern opinion points to the white clover,— *Trefolium repens;* but is widely at war with the conditions which we have stated. Mr. Bicheno, in a pithy and learned paper in the Journal of the Royal Institution, points, and we think points convincingly, to the common wood-sorrel,—*Oxalis acetosella,*—a plant which pushes forth its delicate leaves and blossoms with the earliest spring, and is more beautifully three-leaved than even the white clover, and must have formed a most agreeable and healthy salad to the old Irish, who lived chiefly upon flesh, and may be pronounced abundantly worthy of all the honours heaped upon it by both St. Patrick and the Irish people. The wood-sorrel, indeed, is now a comparatively scarce plant in Ireland, while the clover is plentiful; but, in the old times of the Irish forests, before arable cultivation became general, the wood-sorrel may have been plentiful and the clover scarce.

SHARE. See Plough.

SHAW. The haulm of potatoes, beans, and similar plants; also, a wood that encompasses a close. But the word, in both senses, is provincial.

SHEALING. A summer hut or temporary residence in a pastoral district. It used to be common in the Orkneys, the Hebrides, and some parts of the Scottish continental Highlands; and was often of very rude construction, and almost totally destitute of furniture. It was usually constructed in connexion with a system of summer-feeding of cattle, which was called "going to shealing," and which has been superseded by sheep-husbandry and agricultural improvement; and, by an easy metonymy, the name shealing was extended from the hut to the pasture and to the system. "After the crops had been sown, and the peats cut," says Dr. Robertson, in his Survey of Inverness, "the inhabitants removed annually, in the month of June, to their distant pastures, with all their cattle and families; and there, in some snug spot, the best sheltered in all the range allotted to the cattle, they resided for a certain number of weeks, until the pasture became scarce. A trusty person was sent before them to drive away any wandering cattle that might have trespassed within the bounds that were to be preserved. The men returned occasionally to the farm or home-stead, to collect the fuel, or hoe the potatoes, or weed the crop; and when the season for weeding the flax arrived, the women went home for that purpose. When the bounds are extensive, they have frequently more than one of these stations, which are called *ree* or *aree,* in the language of the country, and shealings in English. In such cases, the guardian of the grass was sent forward to another shealing, whenever the family arrived at that destined for their temporary residence. He was called

the poindler, probably because he had public authority to poind, (whence pound,) and confine the stray cattle, and to demand the fine established by law for the trespass. When these pastures were unusually rich, as at the head of a lake or by the sides of brooks in the valleys, the inhabitants of two or more farms associated together, and ate the grass of their shealings in common. This was the season of contentment, and often of festivity. The women employed themselves in spinning wool to clothe their families, and in making butter and cheese for part of their winter provisions; and the youths occupied themselves in fishing or athletic exercises; and at evening the primitive custom of dancing on the green and singing Gaelic songs was not forgotten. The shealings lasted from one to two months or more; and when the pasture was all consumed, they returned to their home steads."

SHEAF. A bundle of corn bound up on the harvest-field. See the articles Bands, Reaping, and Harvest.

SHEARING OF SHEEP. The yearly removal of the fleece of sheep with a pair of shears. The operation should be performed as soon as the old fleece is sufficiently raised from the skin by the growth of the young wool. The best time, in most cases, when the weather proves fine, is generally the early part of June; for when the operation is postponed till the latter part of that month, or especially till July, the carcase of any of the sheep who may be destined to the shambles before the close of summer is seriously injured, and the bodies of all the rest have not a sufficient defence against the mischievous and even destructive attacks of flies in the hottest time of the year. Eight days or so before the shearing, the sheep should be washed; and from that time till the day of shearing, they must be kept in a clean grass field where they cannot soil their wool under banks of earth. See the article Washing of Sheep.

The shearing may be done either under cover or in the open air; a large canvass sheet should be fastened upon the place, and, if necessary, made soft and cushion-like by spreading under it a layer of straw; and a sufficient number of sheep should be penned or housed in the immediate vicinity to keep the shearer or shearers constantly employed. "Everything being arranged, a shearer seizes hold of a sheep, and sets it on its rump at the tail head; and it is kept in that position by resting against his legs. He removes all straws, thorns, burs, or other things which may have adhered to the wool. In this position, the wool is removed from the head and neck, as far as the shoulders, the abdomen, scrotum, and edge of the thighs. The head of the animal is then bent down sideways, and its ribs on one side are curved round. This position is maintained by the shearer placing a leg on each side of the neck of the sheep, and pushing out the opposite ribs by pressing his knees gently against the ribs nearest to him. The wool is then shorn from the far side by the left hand of the shearer, by using the shears from the abdomen to the middle of the back, down as far as the loins. The animal is then placed in a similar position in an opposite direction, so that the right hand of the shearer is employed to shear the wool down to the loin, from the near side of the animal. The sheep is then laid flat on its side, and kept down by the shearer resting on his knee on the ground, and placing the leg between his knee, and the foot over its neck. In the position which the animal is kept down by the right leg, the right hand shears the wool from the near side of the hind quarter, and *vice versa*. The animal is then set at liberty. The wool shears in using should be held close to the body of the animal, with their points, which should be blunted, a little elevated. Every stroke of the shears should be short and narrow, to make a clean clip. The clips of the shears appear in concentric rings round the body of the sheep. The oil of the wool makes the shears clip smoothly; and they are sharpened with a whetstone." All cutting or wounding of the skin during the operation must be carefully avoided; for even the smallest will afford the flies an opportunity for lodging their ovules, and giving rise to maggots; and when any accidentally occurs, it should immediately be touched with a little tar, turpentine, resinous ointment, or sheep salve. A mark is commonly put on the newly shorn body, in order to facilitate the separation of the different classes of sheep on the farm. All dirty portions of the wool about the tail ought to be removed with the shears, and put together by themselves; and the separated fleece should be taken away by attendant women, and treated and laid past in the manner mentioned in the article Fleece. A shorn flock should be repeatedly examined soon after the shearing, with the view of detecting depositions of fly ovules; and all tumours indicative of these should be opened and rubbed with a little mercurial ointment. An ordinarily good workman will shear from 15 to 25 sheep a day; and a very expert one will shear more.

SHEARLING. A sheep that has been once shorn.

SHEARS. A large clipping instrument. Several kinds, of very different size and shape, and for widely different purposes, are used on farms. The sheep shears of the present day seem to be the same in form as the sheep shears used by the ancient Romans.

SHED. See Farm-Buildings.

SHEEP. A well known and important genus of ruminating animals. It comprises several wild species and a vast number of domesticated varieties or breeds. It is most extensively diffused, and exists and feeds and prospers under a vast diversity of conditions. The interest of it, in all its forms, to a zoologist, is very great; and

the importance of it, in its chief domesticated breeds, to farmers and entire nations, has always been high, and rapidly increases with the progress of civilization, of agricultural improvement, and of manufacturing enterprise. "No animal," says one writer, "varies more than the sheep, and none so speedily adapts itself to climate. It would almost appear that Nature had bestowed upon it a constitution so pliant as to enable it to accommodate itself to any point in a wide range of temperature; for it has accompanied man to every quarter of the globe, becoming impressed at every change with some peculiarity, alterable only by a change of situation, and varying, we might almost affirm, with the weather; for where the temperature is equable, there does the animal preserve an atmospheric stamp, and defy all efforts to alter the breed,—while, under a fluctuating sky, we can model it at will." "No other animal," says another writer, "is, in my opinion, worthy of so much attention as the sheep, it being alike valuable to the farmer and to the nation,—to the farmer, because it is raised with ease and in situations where other animals could not exist, and in general makes a better return for the quantity and quality of food consumed than any other animal,—to the nation, as supplying a staple article of food, and giving employment to thousands of artisans by the conversion of wool into manufactures. In fact, the production and general management of sheep claims to be treated as the foundation of good and profitable husbandry."

The general characteristics of the sheep as compared with those of the closely allied goat genus, are noticed in the article Goat; the principal wild species of sheep are described in the articles Argali and Musmon; the methods of improving and multiplying the domestic breeds of sheep are discussed in the articles Breeding and Crossing; some important points in the management of sheep, as to feeding and fattening, are treated in the articles Fold, Food of Animals, Feeding of Animals, Fattening of Animals, Aftergrass, Pasture, Grass Lands, Mustard, Turnip, Rye, and some others; the chief points in the management of ewes, with reference to reproduction, are discussed in the articles Abortion and Parturition; an important point, in the management of sheep flocks, when removing them from place to place, is noticed in the article Driving; the slaughtering of sheep and the preparing of their carcases for the market are treated in the article Meat; the characteristics and diversities of their flesh as food for man are noticed in the articles Mutton and Lamb; the properties, uses, and preparations of their other products are mentioned in the articles Wool, Milk, Cheese, Skin, Leather, and Horn; and the causes, symptoms, and treatment of diseases which attack them are discussed in the respective articles on these diseases, such as Braxy, Rot, Hydatid, Pining, Louping-Ill, Scab, Diarrhœa, Dysentery, Inflammation, Pneumonia, and many others. We therefore do not need, in the present article, to touch on any of these numerous topics.

General View of the Sheep Genus.—The generic characters of the sheep may be briefly stated as follows:—The horns are directed backward, downward, and forward, in a somewhat spiral form; the chaffron is naturally convex; a sinus occurs at the internal base of the toes in both the fore feet and the hind feet; two smaller toes or rudimentary hoofs occur behind the larger anterior pair; the tail is always short in the wild races, but varies in length in the domesticated breeds; the teeth amount in all to 32,—and comprise 8 incisors in the lower jaw, no incisors in the upper jaw, and 6 molars in each side of both jaws. But in its domesticated state, and very especially in its wild one, sheep are distinguished from goats and other species most nearly allied to them, far more by mental tempers and dispositions than by physical characteristics.

Wild races of sheep inhabit the elevated regions of Europe, Asia, Africa, and America, and comprise chiefly the several species and varieties of musmon and argali. They differ greatly from one another, and still more from the domesticated breeds, in habits and in specific characteristics; and, in some instances, they blend away into near resemblance to wild goats on the one hand or to domesticated sheep on the other; yet, in general, they exhibit very boldly the true characteristics of their genus, and may be regarded as, in many mixed methods, and often in their respective localities, the common or aggregate source of the multitudinous and very diversified domestic breeds. Some races of a medium character between wild and tame inhabit parts of Caubul, Persia, and the countries of the Turcomans and others in the regions round the Caspian Sea; and one of the best known of these has a very coarse grey hairy fur, outward-bent horns like those of the argali, and a head exactly similar to that of the ram on the ancient oriental sculptures; and this race, together with domesticated varieties of it, is the common cultivated sheep of a large portion of Arabia, Tartary, and Hindostan. Wild sheep, with seemingly other distinctive characteristics than those of any known existing races, are obscurely mentioned by ancient credible authors, or figure somewhat phantasmagorically in the descriptions of ancient fanciful writers. Whether any inhabited Western Europe, cannot certainly be affirmed; though the credulous chronicler Boetius speaks of sheep in the remote Hebridean island, St. Kilda, who had bodies larger than the largest goats, and horns longer than those of oxen, and tails reaching to the ground; and Pennant states that a bas-relief figure of an animal corresponding to this description was found on the wall of Antoninus in the vicinity of Glasgow.

The domestic breeds are prodigiously diversified, not only in modifications of the natural characteristics which they possess in common with the wild races, but in all the characters of shape and structure and wool and carcase and habit which belong peculiarly to themselves. Some of the rudest of them may easily enough be traced up to ancestral connexion with some one of the wild races; but the vast majority exhibit strong and intricate marks of a mixed descent; and some are, with good reason, supposed to show broad traces of a more or less free hybridizing with goats; and many or even most of the finer ones have resulted, either from a series of crossings between previously well modified breeds, or from the prolonged, steady, and combined influence of peculiar climate, peculiar food, and peculiar treatment. "We may believe, then," as Professor Low remarks, "that the domesticated sheep, the *Ovis aries* of naturalists, is a factitious species, and not one which has been called forth in the natural state. A species of this kind, however, having been formed, by whatever mixtures of blood, the members of it must have been subject, like every other family mixed or pure, to vary under the influence of external agencies; and thus, independently of the differences produced by differences of origin, there are those which have been produced by climate, food, and domestication, giving rise to those great varieties which, even under the narrowest geographical limits, present themselves." The longer, too, any species has been reduced to domestication, and the more complete its subservience to the human race, the greater and more remarkable will be the alterations which it undergoes. We need not wonder, therefore, that the very ancient dependence of the sheep on man as its lord and master, should have caused many signal variations from the character of the original type, or that repeated changes of food and climate, and the continuous action of an altered and artificial mode of management, should have produced a multitude of new or anomalous features. We accordingly find that, in most of our subdued varieties, the lengthened limbs and comparatively slender, though strong, active, and graceful forms of the original races have disappeared, and been replaced by heavy proportions, and a consequently indolent disposition,—and that the coarse, dry, brittle coating of hair has been succeeded by that woolly substance, of which human industry and ingenuity now form such abundant and manifold materials for the various uses of domestic economy, and the personal comforts of our race. The prodigious development of the wool, and almost entire disappearance of the hair, would indeed of themselves have sufficed to effect a complete alteration in the general aspect and physiognomy of the species; and this remarkable change has been produced in part by physical causes, and in part by the agency of man, who, aiding or counteracting as he best could the observed tendencies of nature, has contrived to subordinate a general law of climate to his own individual advantage.

The changes produced by domestication upon the dispositions and habits of the sheep are much greater than even those upon his physical properties, and render him eminently suitable to the uses of man, and adapted to the circumstances of enclosed pastures and artificial feeding. "When once completely subjugated, he never again appears to acquire the faculties which fit him for a life of liberty. Give him afterwards what freedom we may, he remains more or less dependent upon us, and would fall a prey to wolves and the swifter feræ, were he not under human protection. Yet he is not the stupid and insensible creature which some represent him to be. When entirely subdued indeed, his natural instincts are blunted, and he loses the providence and sense of danger which are natural to him; but when left in a state of comparative liberty, as on the mountains of Scotland and Wales, he shows that, though comparatively feeble, he is not without the power of guarding himself from danger. When attacked by dogs or foxes, the flock forms a circle, with the rams in front, presenting a face to the enemy. The rams rush forward on the assailant, and strike him with their powerful horns; and in their contests with one another for the possession of the females, they fight with amazing determination, stunning one another with the violence of the shocks. The sheep is an exceedingly hardy animal with respect to temperature, his close covering of wool defending him well from cold. He foresees an impending fall of snow, and takes shelter from its violence. When buried underneath the snow, as he sometimes is, he often survives for many days, and even weeks, and may be digged up without injury, provided he have escaped suffocation; for in such a situation, his thick fleece, which, as well as the snow, is a slow conductor of heat, retains the natural warmth of the body in such a degree as to preserve life. The ewe bears that affection to her offspring which Nature has imprinted, as it were, on the heart of every animal. Should mishap befal her young one, she mourns over it, and will not be comforted; should it wander from her side, her anxious bleatings are everywhere heard,—and the little creature rewards her cares with surprising fondness. Who that has seen shearing of the flock, has not marked the startled aspect of the lamb when the mother first runs toward it divested of her covering, and how quickly it is reassured, and how sensibly it expresses its joy, when it hears the well-known voice, and receives the wonted caresses! The sheep appears insensible and stupid, because it is rarely attached to us by acts of familiarity and kindness. But let the orphan lamb be brought up at the shepherd's cot, and fed from his hand, and we shall find it to be nearly as familiar as a dog,—

fond of being caressed, and unwilling to leave its protector to join its fellows of the flock. In countries where the shepherd guides his flock, and does not herd it by dogs in the manner practised in other places, the docility which the animals acquire is wonderfully great. Where the shepherd leads, they follow; they observe his motions and hear his voice,—and when he uses a pipe or horn, they listen to the well-known sound, and obey the signal. In the Alps of Switzerland, and in the mountainous parts of Italy, in Greece, and elsewhere, we are yet charmed with this remnant of pastoral simplicity and innocence. The shepherd boy knows all his little favourites,—he remembers their names, and, when called, they leave the flock and come to him. When the numbers are great, he selects a few, teaches them their simple lesson, and they become the guides of the rest to their allotted pastures, and learn to collect the wanderers. The music of the mountain shepherd we find to be no poetic fiction. In the mountains of the South, we yet hear the soft and artless tones of his pipe. In the morning he leads forth his little flock, and plays as he marches at their head, and at sunset returns in like manner to the fold, where he pens them, that they may be kept from the wolves."—[Low's Domesticated Animals.]

The connexions of sheep with their shepherd in the open, arid, sparce, precipitous hill-pastures of the East, where beasts of prey abound, and deep, dark, unscaleable chasms of vast depth and danger in the rocky mountains are numerous,—their profound dependence on him for protection from the most terrible forms of death,—their frequent need of restoration by him, at the peril of his own life, from dismal solitudes into which they have wandered,—their following him to the most verdant pieces of the hills and to the banks of purling brooks,—their knowledge of his voice, their attachment to his person, and the tender care and caressing affection which he continually renders them,—are beautiful and expressive emblems of the connexions of redeemed men with the Redeemer,—how they were all sought out by him in a waste and howling wilderness, and carried back on his shoulders to a place of safety,—how he laid down his life to save them, and took it again to tend them,—how he restores them to right paths, and leads them in green pastures and by still waters, and protects them with his mace and staff,—how they all know his voice, and follow him, and will not listen to a stranger,—and how, eventually and for ever, he will feed them and "lead them unto living fountains of waters" in the better land. "I, even I," said he, in reference to his ancient people, the mere types of his redeemed, "will both search my sheep and seek them out. As a shepherd seeketh out his flock in the day that he is among his sheep that are scattered, so will I seek out my sheep and will deliver them out of all places where they have been scattered in the cloudy and dark day, and will bring them to their own land, and feed them upon the mountains by the rivers, and in all the inhabited places of the country." Multitudes, in fact, of the most graphic passages of the Bible, descriptive of the Divine goodness to men, both for time and for eternity, abound in allusions to the habits and character and treatment of the sheep flocks of the East; and all, besides being exquisitely illustrative of some of the most momentous truths of revelation, place these truths in a light of intense interest and wondrous beauty, to persons who have carefully observed even the mountain flocks of the sheep of our own land.

Sheep were domesticated so early as the lifetime of the first man; and they make a somewhat conspicuous figure in the earliest records of the oldest nations. "Abel was a keeper of sheep;" and all the chief patriarchs, whose characters are sketched in the inspired record, were possessors and tenders of flocks. The sacred scriptures make historical mention of sheep from the earliest times, through all the patriarchal ages, down to the epoch of the kings; and they often describe flocks of them with a richness of colouring and a minuteness of detail which identify the pastoral usages of remote periods with the practices of the wandering shepherds of the East at the present day. "Scarcely anything seems to have changed in the habits of men in those countries of pastoral tribes. Where Abraham pitched his tent, with his sheep and oxen and asses and camels,—where he sat at the door of his tent,—where the stone was rolled from the wells from which his maidens drew water,—there the Arab or the wandering Turcoman encamps, and all the scene is like a vivid panorama of the past. In the case of the present people of the Desert,—their tents, their journeyings, their household cares, their flocks, their camels, their wells,—all inform us with what a matchless fidelity the Sacred History has been told." The sheep figures also in the earliest records of the nations of Southern Asia, on the oldest existing monuments of Western Asia, on the sculptured remains of ancient Egypt, and in the symbols and memoranda of the earliest arts and sciences of the whole civilized world. It was probably introduced to Southern and Eastern Europe, in some of its best or most improved Asiatic varieties, at the very dawn of European civilization; it was highly esteemed by the ancient Greeks, and is prominently and honourably mentioned by their historians and poets; it was introduced to Italy after the foundation of Rome; it probably was introduced to Spain at an early period from Africa; and it seems to have become diffused throughout all western and central and north-eastern Europe at the period of the Roman conquests. In recent times, it has commanded rapidly increasing attention; and at the present day, in the most highly improved agricultural countries of the world, it is more multitudinous,

and possesses a wider connexion with the interests of husbandry, than at any former period.

The names given to the domestic sheep in Britain vary according to sex, age, and other circumstances. "The male," says Mr. Youatt, "is called a ram or tup. While with his mother, he is denominated a tup or ram lamb, a heeder, and, in some parts of the west of England, a pur lamb. From the time of weaning until he is shorn, he has a variety of names; being called a hog, a hogget, a hoggerel, a lamb hog, a tup hog, or a teg, and if castrated, a wether hog. After shearing, when probably he is a year and a half old, he is called a shearing, a shearling, a shear hog, a diamond or dinmont ram or tup, and a shearling wether when castrated. After the second shearing, he is a two-shear ram or tup or wether; at the expiration of another year, he is a three-shear ram, &c.; the name always taking its date from the time of shearing. In many parts of the north of England and Scotland he is a tup lamb, after he is salved and until he is shorn, and then a tup hog, and after that a tup, or if castrated a dinmont or a wedder. The female is a ewe or gimmer lamb until weaned, and then a gimmer hog, or ewe hog, or teg, or sheeder ewe. After being shorn, she is a shearing ewe or gimmer, sometimes a theave or double-toothed ewe, or teg; and afterwards, a two-shear or three-shear, or a four or six-tooth ewe or theave. In some of the northern districts, ewes that are barren, or that have weaned their lambs, are called eild or yeld ewes."

The Varieties and Breeds of Domesticated Sheep.—The domesticated sheep of different countries present an almost endless diversity of form, size, fleece, and other characters; and might, in consequence, be arranged into many groups, and distributed into almost innumerable varieties. Those of Asia comprise two grand classes,—the one with flat tails naked underneath, the other with long, round, wool-clothed tails,—both comprising a great many kinds with widely different characters,—and the former including some remarkable varieties with enormous masses of fat either on the tail or on the haunches. Those of some parts of Africa, as in the north-east, are similar to some of the Asiatic races; those of other parts, as in the north-west and in Abyssinia and Congo, are peculiar, and comprise some very large long-legged kinds; and those of other parts, as in the vast regions of the interior, are in a great measure unknown, but are supposed to be more or less peculiar, and to comprise many varieties. Those of Europe are amazingly diversified, and exhibit very marked indications of a mixed descent, and are generally supposed to have wholly or at least chiefly sprung from crosses and climatic modifications of the imported breeds of Asia and Africa. Even those of the British Islands present extraordinary diversities of size, form, wool, habit, and other characters, and have obviously descended from widely different and manifoldly commixed sources, and seem to exhibit, in no small degree, the effects of the prolonged influence of climate, food, and peculiar treatment, as well as the results of systematic crossing and highly artificial management. We shall, in the sequel of this section, give a brief account, first of some of the most remarkable foreign breeds, and next of all the principal or well-defined British breeds.

The long-legged African sheep, which natively belongs to the coast of Guinea and to some other districts, is probably the largest and tallest of all the domestic varieties. It is $4\frac{1}{2}$ feet long and upwards of 3 feet high; and it resembles the wild musmon in outline of countenance and in general deficiency of wool. The chaffron is arched; the ears are frequently pendant; the neck is short; the legs are remarkably long; the tail reaches to the heels; the skin of the throat is frequently pendant; and the horns are generally short, and form not quite an entire circle round the ears. The colour varies from white to brown, black, and pied; and the covering comprises portions of wool on the croup, back, and flanks, but consists elsewhere of hair, which, on the nape of the neck and shoulders, assumes the form of a heavy mane hanging down to the breast. This animal was introduced to Europe by the Dutch, and naturalized in East Friesland. A cross of it with the common breed produced the Texel sheep or *Mouton Flandrin*, the ewe of which is remarkable for always producing several lambs every year, and whose wool, while possessing a certain degree of fineness, is of great length.

The Morocco sheep has a somewhat near affinity to the long-legged Guinea sheep, yet possesses some decided characteristics of its own. The wool of it is long; the hair on the neck is short, undulating, and of a rufous brown colour; the ears are small and horizontal; the horns are small and turn spirally outwards; the scrotum forms two separate sacs; and the general colour is white, with markings of liver-coloured brown. A specimen of this breed was at one time in the possession of the late Sir Joseph Banks.

The Congo sheep is also akin to the long-legged Guinea sheep. Its proportions are similar; but its flanks are hollower, its chaffron is greatly arched, and some of its other characters are widely different. It is meagre and powerless; and, instead of wool, is covered with loose hair, slightly lengthened beneath the throat. The horns are short, and turned back upon the neck; the ears are pendulous; the throat is wattled or pouched; and the tail is very long, slender, and almost naked. The general colours of the fur are composed of large clouds of rufous coloured brown upon a white ground. The females are hornless.

The Angola breed are better proportioned. The chaffron is scarcely arched; the horns are small; and the wool, at least on those called Coquos, is finer and more abundant. The others

are rather hairy. In all, the tail is very long, the ears only horizontal, and the prevailing colour white, with broad rufous spots. Of the Angola race, one of the most remarkable is the Zunu or goitred breed, which is low on its legs, the hairs close, the ears pendulous, and the tail reaching to the fetlocks. It is very delicate, and has a singular mass of fat, in the form of a high collar, behind the horns, and resting on the occiput. The horns are short, slender, and turned inwards towards the forehead. Upon the larynx another mass of fat hangs like a goitre, under the throat; and the forehead is so prominent, that a deep depression occurs between the eyes. The ears, neck, body, and superior part of the tail are pale brown; the head, goitre, throat, legs, belly, and inferior half of the tail, white.

Broad-tailed sheep form a class or great group, and comprise several varieties which inhabit far-distant countries, and which, while they agree in the character of the tail, differ from one another in some other particulars. They are generally of a medium size, the chaffron arched, the ears pendant but mobile, and the wool coarse and long, and hanging in thick patches. The horns are large and directed first backwards, and then downwards and forwards; and they are sometimes quadruple, and sometimes entirely wanting. The tail is greatly enlarged laterally, in consequence of an enormous accumulation of fat in the cellular tissue; it is naked and flesh-coloured beneath; and its interior surface is marked by a slight longitudinal furrow.

The Hottentot broad-tailed sheep is characteristic of Southern Africa, although it now occurs also in Madras and Bengal. It is of small size, and handsomely made. The tail, the end of which is turned up and sharp pointed, is furnished beneath with a considerable expanse of fat, which is rather thick than laterally spread; the wool is replaced by short soft white hair; and the tips of the ears, the knees, houghs, fetlocks, and a spot around each eye, are fulvous. This is a delicate variety, almost entirely useless as sea-stock, as it usually perishes during the first gale of wind. It is one of a vast race, which, according to Major Smith, is spread, with various modifications, over Egypt, Barbary, the Levant, India, China, and Russia.

The North African broad-tailed sheep is not uncommon in Barbary, and is sometimes found even in the island of Corsica. It has three or four horns, and pendulous ears; and its tail is not very broad. Its general colour is white, the posterior parts being covered with wool, and the head and shoulders with loose soft hair. A breed of this kind crossed with the Emmemas or Guinea sheep, was in the possession of Mr Wilding. Its entire covering consisted of soft silky hair, of a silvery whiteness. The hair of the fore and hind part of the neck was of great length; and there was a black spot on each knee and thigh. So forcibly was this animal acted upon by the colder climate of England, that in the month of November it began to assume the soft woolly coat of our native breeds.

The Astracan breed is remarkable in its youth, for the beauty of its fine frizzled coat, frequently used in the natural state as furs. These are taken from the lambs, of which the mothers are slain a few days previous to yeaning. The adults are covered with longer and coarser wool, beneath which the black and white coating of the young may be detected, but not in the frizzled state.

In northern and middle Asia, another broad-tailed breed occurs, remarkable for having four, five, and even six horns. The ears point forwards and downwards, the throat is wattled, the chaffron convex, and the wool coarse. This breed is found along the banks of the Wolga and Jennissai, and forms the flocks of the Kirguise.

The fat-rumped sheep of Southern Russia is, in a sense, a broad-tailed breed, yet perhaps belongs to another and peculiar race. The caudal vertebræ are very few; and on each side of the tail there is a large rounded mass of fat, separated beneath, but united at the tail itself. This breed is characteristic of the Steppes of the south of Russia, but also occurs in Persia and China. The wool is coarse, frequently dark coloured, or nearly black; the hoofs are long; and the ears are pendulous.

The fat-rumped sheep of Tartary has long pendulous ears, and a very short tail. The quality of the wool is good, but the colour is mixed,—that of the male being roan, or light brown, mingled with white, and that of the female black and white. This is probably the species figured by Bewick, although he states, that, instead of a tail, it had merely a large protuberance of fat behind, covering the rump. It appears to have either no horns at all, or very small ones.

A variety of the fat-rumped sheep of Tartary, seemingly crossed with the sheep of Astracan, is found in the Mysore. It is hornless, with narrow pendulous ears and a very short clean tail; and the wool, very fine, is particularly curled, in small meshes, shaped like a cork-screw; the eyes are blue, and the colour pure white. It is the most beautiful breed of India. The late Sir Joseph Banks had a specimen which came from the Gardens of Tippoo Sultan, at Seringapatam.

The long-tailed sheep, like the broad-tailed ones, form a class or group; but they are, as yet, obscurely known. The tail is so long as to trail upon the ground; the horns are middle-sized, and twist spirally from the side of the head; and the wool is coarse, and frequently black. Some breeds of this group are found in Circassia and the south of Russia.

The many-horned sheep of Iceland is one of the most remarkable of the European breeds. It is a small animal; and has large irregular horns, varying in number from two to six, or even more, and not turned spirally, but simply

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curved backwards, upwards, or to one side. The coat shows a beautiful adaptation to the rigours of the Icelandic climate, and consists as it were of three layers,—long coarse hair, thick intermediate wool, and fine close interior down. The head, tail, and extremity of the limbs, are covered with short hard hair. The hoofs are long, narrow, and irregular, in consequence of the animals living so much among the soft snow, which scarcely wears them. Another breed, large and white, likewise occurs in Iceland, distinguished by the same peculiarities in the form and number of the horns. This has probably been obtained by a cross from some continental race. The Icelanders feed their sheep, when the summer crop happens to fail, on fish bones. They also observe that their flocks fatten rapidly when they can obtain a good supply of scurvy-grass.

The Wallachian sheep are also a strongly characterised European breed, and have been regarded by some authors as a distinct species. The horns of the male are remarkable for their length and upright position, and form a complete spiral turn at their base, and then ascend spirally upwards; and those of the female are divergent, and twisted on their own axes. The fleece is long, coarse, and undulating; the ears are small and drooping; and the tail is long. The general colour is white; and the dimensions equal those of an ordinary sized sheep. This is a handsome showy animal, common in Hungary and Wallachia, from which numerous flocks are driven to the market of Vienna. Belonius says they occur in Crete; and the ancients are supposed to have described them under the name of *Strepsiceros*.

The Merino or Spanish sheep is the most celebrated of all the European breeds. This variety is distinguished by the size and strength of its horns, which form a regular spiral turn on the sides of the head, and by its wool, twisted in cork-screw ringlets, and beautifully soft and fine. The breed, though said originally to have come from Barbary, is now widely spread, and in great perfection, over Spain; and many of the most esteemed of the French races owe their excellence to a preponderance of the Merino blood. There seem to be two principal kinds of sheep in Spain,—the coarse-woolled, which always remain in their native pastures, and are housed every night in winter,—and the fine-woolled, which are always in the open air, and travel every summer from the cool mountains of the northern parts of Spain, to feed in winter on the southern and warmer plains of Andalusia, Mancha, and Estremadura. M. Bourgoanne, a French gentleman, who resided many years in Spain, gives the following account of the wandering sheep of Segovia: "It is in the neighbouring mountains that a part of the wandering sheep feed during the fine season. They leave them in the month of October, pass over those which separate the two Castiles, cross New Castile, and disperse themselves in the plains of Estremadura and Andalusia. For some years past, those of the two Castiles, which are within reach of the Sierra Morena, go thither to pass the winter, which, in that part of Spain, is more mild. The length of their day's journey is in proportion to the pasture they meet with. They travel in flocks from 1,000 to 1,200 in number, under the conduct of two shepherds, one of whom is called the Mayoral, the other the Zagal. When arrrived at the place of their destination, they are distributed in the pastures previously assigned them. They return in the month of April; and, whether it be habit or natural instinct that draws them towards the climate which at this season becomes most proper for them, the inquietude which they manifest might, in case of need, serve as an almanac to their conductors. The Leonese races (among which that called *Cavagne* is the most distinguished), after having been cantoned during the winter near Merida in Estremadura, on the left bank of the Guadiana, are marched about the 15th of April, in flocks of 2,000 and 3,000, across the Tagus at Almarez to Villa Castin, Trescasas, Alfaro, Espinar, and other stations, where their fleeces are shorn; and when this operation is completed, each division continues its route towards the province of Leon, where it is partitioned into flocks of 500 over the pasturages of Cervera, in the neighbourhood of Aquilar del Campo. The Soriane races, dwell during winter in the confines of Estremadura, Andalusia, and New Castile. Towards the end of April, they cross the Tagus, at Talaveyra de la Reyna, and the Puente del Arzobispo, when their march is directed towards Madrid, from whence they travel to Soria, where a portion is placed among the neighbouring mountains, and a portion crosses the Ebro, and is located on the pastures of Navarre and the Pyrenees. All these wandering races are known under the general denomination of Transhumante. The most esteemed among the stationary tribes, or Estantes, dwell behind the gorges of the Guadarama and of Somosierra, and in the environs of Segovia, near certain residences, called Esquileos, where the sheep-shearing is carried on." The Leonese excel all the other breeds, both in the form of their body and in the abundance and quality of the wool.

The form of the Merino sheep does not accord with the English ideas of symmetrical proportion; and the pendulousness of its skin beneath the throat is particularly offensive to the eye of an English breeder; but the fleece, besides being remarkable for its bulk and character, affords three distinct kinds of wool,—one from the back and belly, another from the neck and sides, and a third and coarsest from the breast, shoulder, and thighs. "The first impression made by the Merino sheep on one unacquainted with its value," says Mr. Youatt, "would be unfavourable. The wool, lying closer and thicker over the body than

in most other breeds of sheep, and being abundant in yolk, is covered with a dirty crust, often full of cracks. The legs are long, yet small in the bone; the breast and the back are narrow, and the sides somewhat flat; the foreshoulders and bosoms are heavy, and too much of their weight is carried on the coarser parts. The horns of the male are comparatively large, curved, and with more or less of a spiral form. The head is large, but the forehead rather low. A few of the females are horned, but, generally speaking, they are without horns. Both male and female have a peculiar coarse and unsightly growth of hair on the forehead and cheeks, which the careful flock-master cuts away before shearing time; the other part of the face has a pleasing and characteristic velvet appearance. Under the throat there is a singular looseness of skin which gives them a remarkable appearance of throatiness or hollowness in the pile; the pile when pressed upon is hard and unyielding; it is so from the thickness with which it grows upon the pelt, and the abundance of the yolk detaining all the dirt and gravel which fall upon it; but when examined, the fibre exceeds in fineness, and in the number of serrations and curves, that which any other sheep in the world produces. The average weight of the fleece in Spain is 8 pounds from the ram and 5 from the ewe; when fatted, these sheep weigh from 12 to 16 pounds per quarter." But, on the other hand, the Merinos have very serious defects. "When we regard them as animals to be fattened for human food," says Professor Low, "they are of an inferior class. Their flesh is of indifferent quality, and they are of tender constitutions. The females are the worst nurses of any race of sheep which inhabit Europe. So great is their defect in this respect, that in Spain half the lambs are killed in order that the ewes may be enabled to suckle the remainder, it being calculated by the Spanish shepherds that the milk of two ewes is required to bring up one lamb in a proper manner. Abortions are frequent, parturition is difficult, and the ewes are more apt to desert their offspring than any other sheep which are known to us. In these respects, the Merinos resemble the ancient *Oves molles* of Italy, which were remarkable for the delicacy of their constitution, their voracity, unthriftiness, and inferior power of secreting milk. The Spanish Merinos, although retaining a certain degree of wildness, are yet very docile in their tempers. No sheep place themselves more unreservedly under the guidance of the shepherds; and, although late in arriving at maturity, and difficult to be fattened, they are readily satisfied with dry and innutritious pastures. When put amongst other sheep, they keep together, generally on the higher grounds. At night they form themselves into a circle, the rams and stronger sheep being on the outside, retaining thus the instincts which they had acquired in their native habitation." The Merino breed were introduced to Britain in 1788, and pushed into prominent notice among British farmers in 1804, and taken under the special protection of a great and influential public society, instituted for the purpose, in 1811; and they have, in a great diversity of places and circumstances, both by themselves and by intermixture with other breeds, been put to a very ample trial in our country. All the crosses from them, however, have either so totally failed or been so excessively diluted, that they may already be regarded as quite extinct; and though the pure naturalized Merinos have entirely succeeded, and are found to improve in size, in lactiferousness, in length of wool, and in external form, yet they are not hardy enough for all ordinary situations, and do not yield so much profit to the farmer as some of the best British breeds.

The French sheep, commonly called Mouton de Picardie, de Brie, de Beauce, are of medium dimensions, and measure about 2 feet 4 inches (French) in height at the shoulder. The rams are usually hornless, the head narrow, and, in common with a portion of the neck and legs, covered with a short, rough, hairy coating. The wool of the body is coarse and abundant, and hangs in large separate masses, composed of straight untwisted filaments. The usual colour is white. The French writers distinguish several varieties, or mixed races, which, like our own, commonly bear the name of the district of which they are the most characteristic. La Flandrine is long and tall, and is supposed to have originated from a cross by an African ram; it is also called mouton de Texel. La Solognote has a fine slender head, usually hornless, and the wool frizzled at the extremity of the meshes only. La Berichonne is distinguished by the length of its neck. The head is without horns, and furnished with wool on its summit. The fleece is fine, white, short, close, and frizzled. La Roussillonaise produces a very fine wool, which partakes of the nature of the Spanish fleeces, being spirally twisted in a similar manner. It has probably been crossed with the Merino race. There are many demi-merinos in France; and of these the wool is usually longer, though less fine, than that of the true Spanish breeds.

The British breeds of sheep have been classed into horned and hornless, into long-woolled and short-woolled, into upland and lowland, into ancient and modern, and into natural and cross. But they may, much more fully and with far greater advantage, be distributed into the Scottish Insular, the Welsh, the Irish, the English forest, the old upland, the mountain, the down, and the long-woolled. According to this classification, the Scottish Insular breeds comprise the Shetland and the Hebridean; the Welsh breeds comprise the mountain Welsh, the soft-woolled Welsh, and the Radnor; the Irish breeds comprise the Wicklow, the Kerry, and the long-

woolled Irish; the English forest breeds comprise the Dartmoor and the Exmoor; the old upland breeds comprise the old Norfolk, the Penistone, the old Wiltshire, the Dorset, the Somerset, the Portland, and the Ryeland; the mountain breeds comprise the blackfaced heath, the Herdwick, and the Cheviot; the down breeds comprise the Southdown and the Hampshire down; and the long-woolled breeds comprise the Lincoln, the Romney Marsh, the Bampton-Nott, the Cotswold, the new Oxford, and the Leicester.

The Shetland sheep are small handsome animals, with short fine fleeces. They comprise numerous subvarieties, and have been somewhat largely crossed, in many places, with breeds from the nearest parts of Continental Europe; yet they possess a quite marked family character, and may all, more or less, be readily ascribed to a common origin. They are wild, active, and very hardy; and have slender limbs and short broad tails; and either are hornless or have short and often straight and upright horns similar to those of the goat. Some are white, some black, some brown, many grey, and many curiously streaked or otherwise marked with intermixtures of black and white. Their wool is soft and cottony, and adapted to very fine manufactures, and has, in some instances, been found to rival the merino wool. "They have three different successions of wool yearly, two of which resemble long hair, more than wool, and are termed by the common people *fors* and *scudda*. When the wool begins to loosen in the roots, which generally happens about the month of February, the hairs or *scudda* spring up; and when the wool is carefully plucked off, the tough hairs continue fast, until the new wool grows up about a quarter of an inch in length, then they gradually wear off; and when the new fleece has acquired about two months' growth, the rough hairs, termed *fors*, spring up, and keep root, until the proper season for pulling it arrives, when it is plucked off along with the wool, and separated from it at dressing the fleece, by an operation called forcing. The *scudda* remains upon the skin of the animal, as if it were a thick coat, a fence against the inclemency of the seasons, which provident Nature has furnished for supplying the want of the fleece. The silver-grey wool is thought to be the finest; but the black, the white, the *mourat* or brown, is very little inferior; though the pure white is certainly the most valuable for all the finer purposes in which combing wool can be used." The Orkney sheep are radically the same as the Shetland sheep, but have been more frequently mixed with other breeds, particularly with the Dutch, and have not so fine wool.

The Hebridean sheep possesses considerable affinity to the Shetland sheep, but is among the smallest of its kind, and of comparatively little value. Its shape is thin and lank; its horns are usually short and straight; its tail is very short; its face and legs are white; and its wool is sometimes bluish-grey, sometimes brown, sometimes deep russet, and sometimes a combination of all these colours. The carcase, on the average, does not weigh more than about 20 or 22 lbs.; and the wool is proportionally small in quantity, and has different qualities on different parts of the same fleece, but, under favourable circumstances of pasture and management, is very fine and has a softness similar to that of the Shetland sheep.—A remnant of an ancient race of sheep occurs in several of the northern counties of Scotland, characterised by yellowness of face and legs, and by dishevelledness and unequal quality of fleece, part of it being fine and part coarse.

The Welsh mountain sheep are similar in size to the Hebridean sheep, and have horns and habits similar to those of goats. They are wild and very active, and frequent the highest parts of the mountains, and feed largely on alpine aromatic herbage. They have black hair on their face and legs, and a ridge of hair on the back, throat, and dewlap; and their fleece is of various colours,—principally black, brown, and grey.—The Welsh soft-woolled sheep are also a mountain breed, and only about one-sixth or one-fifth larger than the preceding breed; but they are much more valuable, and far more generally diffused, and may be regarded as the distinctive breed of Wales. They have exceedingly active habits, and cannot be confined within any low or ordinary enclosures. Their general form is slender; their hind-quarters are long, and somewhat similar to those of the deer; their neck is thin, and is more arched backward than that of any other variety of sheep; their coat contains some mixture of hair, though less than that of other mountain breeds; their throat is so hairy as to have a sort of beard; their fleece weighs between one and two pounds, and is long-woolled, and furnishes the material for the well-known Welsh flannel; and their flesh is of excellent quality, and has long been celebrated under the name of Welsh mutton. A subvariety of this breed, of a larger size and better fed, occurs in Anglesea.—The old Radnor sheep possesses some resemblance to the Welsh soft-woolled sheep, and a greater one to the Welsh mountain sheep, but has a larger size and a better shape than either, and is probably a mixed offspring of the two enlarged and improved by feeding on better pastures.—The new Radnor sheep is an improved subvariety of the old, and has been crossed with the Shropshire and other breeds, and is often the only sheep meant when farmers of the present day speak of the Radnor.

The Wicklow sheep inhabit principally the Wicklow mountains on the east coast of Ireland; and they considerably resemble the mountain and the soft-woolled sheep of Wales, in both form and habit. They are small and wild; and comprise a comparatively small-sized and coarse-

woolled variety in the poorest and loftiest situations, and a comparatively large-sized and fine-woolled subvariety in the richer and lower situations. They have no horns; their faces and legs are generally white, but sometimes black; their wool is tolerably fine and rather long; their neck and back, especially in the loftiest and bleakest pastures, are protected by a ridge of hair which causes the rain to shoot off; and their flesh is excellent, and causes the lambs to be in great request for the Dublin shambles.

The Kerry sheep are the most characteristic of a number of small mountain breeds who inhabit the highland districts of the west coast of Ireland. They are larger than the Wicklow and the Welsh mountain sheep; yet they feed and grow slowly, and are comparatively unthrifty. They present some general resemblance to the antelope races; and are hardy, active, restless, and roaming. Their shape is never full or rotund; their fat accumulates only in the interior; their wool is coarse and hairy on the back and haunches, and fine and soft on the ribs; and their flesh, in general, is excellent.

The long-woolled sheep of Ireland comprise many subvarieties; and are diffused throughout all the Irish plains and valleys. The aboriginal breeds of them, and even those which at no remote period furnished the main supply to the great annual fair of Ballinasloe, were large in size, exceedingly coarse in form, and very unthrifty in feeding and fattening habits. "I never," said Mr. Culley, "saw such ill-formed ugly sheep as these. The worst breeds we have in Great Britain are much superior. I know nothing to recommend them except their size, which might please some old fashioned breeders, who can get no kind of stock large enough. They are supported by long, thick, crooked, and grey legs; their heads long and ugly, with large flagging ears, grey faces, and eyes sunk, necks long, and set on below the shoulders; breasts narrow and short, hollow before and behind the shoulders; flat-sided, with high, narrow, herring backs; hind quarters drooping, and tail set low." But these ungainly creatures, ever since about the time when Mr. Culley wrote, have been more or less crossed with other breeds, principally the new Leicester; so that their successors of the present day, though still faulty and inferior, have lost all the old excessive ugliness, as well as a good measure of the other bad points. The long-woolled Irish sheep now do well for the butcher, but ill for the wool-merchant, and indifferently for the breeder. Their heads are large; their sides are flat; their breasts are narrow; their general form is coarse; and their fleece is harsh and of medium quality and weight.

The Dartmoor sheep are hardy, and well adapted to the district from which they take their name. They are small, wild, restless, and difficult to be confined; but though bred on the heath, are commonly fattened on the plains. They grow slowly, and attain an average weight of about 10 lb. per quarter. Their face and legs are white; their wool is soft; and their flesh is in much demand, not only in near but in distant markets.—The Exmoor sheep are rather smaller than the Dartmoor, but greatly resemble them in general appearance, in disposition, in habits, and in value. Their head, neck, and bones are small and delicately formed; their body is comparatively narrow and flat-sided; and the males have a beard under the chin somewhat like that of goats.

The Norfolk sheep are a wild hardy race, and were formerly diffused through the sheep-walks of Norfolk, Suffolk, and Cambridgeshire. They are voracious eaters, and have a restless disposition, and cannot easily be retained in limited pastures. They have large spiral horns, black faces, and long, large-boned, dark-grey legs. The carcase is small, lengthened, thin, and weak, with a narrow chine, and weighs from 16 lb. to 20 lb. per quarter. The flesh does not stiffen well in hot weather, and is supposed to become tainted sooner than most others. The wool is short and fine, and seldom weighs more than 2 lb. In many places, this breed have been crossed with the down sheep, and very greatly improved; and in others, where they were at one time reckoned good folding sheep, they have been entirely and profitably superseded by the Southdowns.

The Penistone sheep inhabit a heathy district of about 500 square miles in extent on the mutual borders of Yorkshire, Derbyshire, and Lancashire. Their general form, and especially their extremities, are very coarse; their face and legs are white; their shoulders are heavy; their limbs are bony; their feet are large; their sides are flat; their tail is long, bony, and muscular; their wool has a silky appearance, but is harsh and wiry; and their flesh is much esteemed for its juiciness and flavour. The rams are singularly larger than the ewes and wethers; and they alone have horns,—which are very large, and lie close to the head, and project forward.

The old Wiltshire sheep formerly existed throughout most of Wiltshire, and in many other parts of the south of England; but they are now nearly extinct. They are large, coarse, and ungainly, and are very slow fatteners, and abound in properties which enlightened modern sheep-farmers reckon undesirable; but they have fine though scanty wool, and were therefore for a long time tolerated and even liked. Their head is large and coarse; their nose is arched and has been called Roman; their face and legs are white; their sides are flat; their limbs are long and thick; and their belly is destitute of wool. Both sexes are horned.

The Dorset sheep are a very ancient breed, and by far the best of the old horned varieties; and, though come down uncrossed from a very remote period, they maintain a high or rival place among some of the modern improved races.

They abound in Dorsetshire and in part of Wiltshire; and occur, in scattered flocks, throughout a large portion of Britain. Their body is tall and light; their faces are white, their legs long, and their wool short. Their shoulders are broad at the top, and lower than the hind quarters. The back is tolerably straight, the carcase deep, and the loins broad. The fleece seldom weighs above 3½ pounds; and the staple is not often more than two inches long. This breed is very prolific; and the ewes occasionally bring forth twice a-year. It is from them that the luxurious tables of London are supplied with Christmas lamb. The victims are reared in little dark cabins; and the ewes are kept in a neighbouring field, and fed with oil-cakes, corn, hay, &c., and introduced, after certain intervals, to give suck to their young. The latter are kept very warm and clean, and their lodgings are constantly littered with fresh straw. See the article Lamb. The wool of the Dorsetshire sheep, though not abundant, is of a superior quality, the fine Wiltshire cloths being fabricated from it.

The Somerset sheep are a subvariety of the Dorset breed. But they are larger and taller, and have more arched profiles, and have noses, not of a black or white colour, but of a pink or fleshy colour, similar to the Merinos. Their lambs also are larger, and their wool somewhat longer, yet of nearly the same fineness. Both the Somersets and the true Dorsets, however, have, for a considerable time past, been increasingly dislodged by the Southdown race from some of their grounds, and increasingly crossed and modified with them in others. Some or even many subvarieties of the same group as the Somersets and the Dorsets, were formerly more or less rife in the southern parts of England; but are now quite or nearly extinct.

The Portland sheep inhabit the Isle of Portland; and are cognate to the Dorsets, but are much smaller, and constitute a perfectly distinct breed, and have existed as such from an untraceably remote period. Both males and females have horns; and they have a good shape and a gentle disposition. Their face and legs are white, but have a tinge of dun; their wool is coarser than that of the Dorset, and makes a very light fleece; and their mutton is delicate and excellent, and fetches a good price in the market.

The Ryeland sheep took their name from a sandy tract of country, which was formerly used much for the raising of rye crops, in the valley of the Wye; but they have borne other names in the principal districts where they have prevailed,—and particularly that of Hereford sheep in most parts of Herefordshire, and that of Archenfied sheep or of Ross sheep in the tract of country situated between the Forest of Dean and the Malvern Hills. They are small and hornless; and have existed, as a distinct and unmixed breed, from a remote period; and have, for ages, been more or less cultivated throughout a large portion of Herefordshire, Monmouthshire, Gloucestershire, Shropshire, and Warwickshire, on account of the softness and fineness of their wool. "These sheep," says Spooner, "are of small compact forms, without horns, quiet in their habits, patient, and hardy. The mutton is delicate and juicy, and the carcase from 12 to 15 pounds per quarter. The wool is white, and extends over the face, and forms a tuft on the forehead. They are principally distinguished for the fineness of the wool, which is superior, for carding purposes, to all other of English produce, the Merino alone excepted. This formerly occasioned it to be in great demand, and to realize a good price; but since the general importation of the Merino wool, its great superiority has caused the demand for the Ryeland to be greatly diminished, and its price to fall in proportion. Thus the fleece being light, averaging only two pounds, it will not repay the trouble and expense that used to be incurred in keeping these sheep in large cots or houses, containing from 100 to 200, where they were fed with peastraw and dry forage,—a practice found to conduce very much to the fineness of the fleece, and which was generally practised when the Lemster wool, as it was termed from the city of Leominster where it was sold, was in the zenith of its prosperity." The Ryeland sheep, however, have been so extensively substituted by some of the larger races, and so generally modified, in places where they still exist, by old crosses with the Merinos, the Southdowns, and the Cotswolds, and by recent crossings with the Leicesters, that comparatively few of the pure breed now occur in even the districts where, at one time, they were most highly valued.

The black-faced or heath sheep are a very peculiar breed, and have a wild unreclaimed aspect, and inhabit lofty, heathy, barren mountainous tracts throughout the northern counties of England and in many parts of both the southern and the northern highlands of Scotland, from Dumfries-shire and Roxburghshire away even to the Pentland frith. It has existed from time immemorial in the north of England, and found its way many centuries ago into the south of Scotland; but was not introduced into the western, central, and southern highlands of Scotland till periods ranging downward from about the middle of last century, and has now, in a great measure, supplanted the earlier ovine inhabitants of these regions. "This breed," says Professor Low, "is of the smaller races of sheep with respect to the weight at which it arrives, but it is larger and more robust than the Shetland, the Welsh, and the ancient soft-woolled sheep which it displaced. It somewhat resembles the Persian, so that it might be conjectured that it is derived from the East. But it is more natural to assume that its peculiar characters have been communicated to it by the effects of food and

climate, in the rough heathy district from which it is derived. The male and the female have horns, very large and spirally twisted in the male, but sometimes disappearing in the female. The limbs are long and muscular, and the general form is robust; but the shoulders are not so low as in the Welsh breeds, nor are the posterior limbs so long. The face and legs are black, and there is a tendency to this colour in the fleece; but there is no tendency to the brown or russet colour, which distinguishes the older fine-woolled races. The fur is shaggy and the wool coarse, in which respect it differs from that of all the other mountain breeds of the country. It is of medium length, and weighs about three pounds the fleece when washed. These sheep are very hardy, and capable of subsisting on the coarsest heaths. They do not, however, like the sheep of Wales, prefer the summits of mountains, but feed wherever pasture can be obtained; and are not so nice in the choice of herbage as the Southdowns, Merinos, and other races derived from countries yielding the finer grasses. Although wild and independent in their habits, they are not so restless as the mountain sheep of Wales and other parts, but can be induced to remain in enclosures, when sufficient food is supplied to them. The ordinary weight of the wethers, when killed at the age of about four years, is 15 pounds the quarter; but individuals are made to exceed this weight, when properly treated and sufficiently fed from an early age. The mutton is not so delicate as that of the sheep of Wales, or the Southdowns of England; but it is more juicy, has more of the venison flavour, and is preferred to every other by those who are used to it. It is the mutton which is principally consumed in all the larger towns of Scotland; and great numbers of the sheep, at the age of three years and upwards, are carried to the pastures of the south, to be fattened for the English markets. An important property of this breed is its adaptation to a country of heaths, in which respect it excels every other. It is this property, as much as its hardiness, that has rendered it so suitable to the heathy mountains where it is acclimated, and where it finds subsistence beyond the ordinary range of other sheep. It feeds on the loftiest mountains, up to the very verge where the heaths give place to the musci and other plants of the higher latitudes. Feeding much on the shoots of heath, these sheep find subsistence, in the times of snow and severe frosts, better than any other in this country. The mothers are hardy nurses, and are able to bring up their young, when they themselves have been exposed to severe privations. A great defect of this breed is the character of the fleece, which, besides being thin on the body, yields wool fit only for the manufacture of carpets and the coarser stuffs. Little general attention has been paid to the quality of the fleece, although it is susceptible of considerable improvement. A defect of the wool, very common in this breed, is the existence of what are termed kemps. These consist of hard and wiry filaments mixed with the pile. They are deficient in the felting property, and in the oily secretion which moistens the true wool. The removal of kemps is effected by superior food, and by breeding from parents free from the defect." Some subvarieties of this breed deviate widely from the ordinary type; some are smaller and less hardy; some are hornless, and want the black colour of the face and legs; and some are degenerated, and others improved. The best are those of Peebles-shire; and among the next best are those of the most northerly parts of England. Some individuals have fine and short wool, and might easily be used for improving the fleece of entire flocks and subvarieties.

The Herdwick sheep are derived from a district of Cumberland round the head of the rivers Esk and Duddon. "The few farms where they are bred," says Bingley, "are called Herdwicks, that is, the district of the Herds, from the circumstance of the sheep having, from time immemorial, been there farmed out to herds at a certain sum per annum." They are hornless, with speckled faces and legs; and the wool is short. Those of the purest breed have only a few black spots on the face and legs. The fleece, which is thick and matted, seldom exceeds $2\frac{1}{2}$ pounds, and is among the coarsest of the short-woolled breeds. The Herdwick sheep are small, lively, and active, easily supporting themselves, even during the severest storms, by the quickness with which they scratch away the snow from the most scanty herbage. They are usually hornless; but Mr. Culley seems to think that they have been crossed by the Heath rams, from the circumstance of some of the males being furnished with horns, and from some 'kempy hairs' being usually intermingled with the wool.

The Cheviot sheep have existed from time immemorial on the grass-clad trappean mountains of the mutual borders of England and Scotland, and particularly on the porphyritic range from which they derive their name; and they have thence spread over the southern highlands of Scotland, and over large tracts of the central and the northern highlands,—in some places supplanting the black-faced heath sheep, and in others competing with them for popular favour. But though so near akin to that race, both in locality of origin and in territory of diffusion, they materially differ from them at once in character, habit, and adaptation; and while very profitably substituted for them on some pastures, have been just as unprofitably preferred to them on others. "The Cheviot sheep," says Professor Low, "are destitute of horns in the male and female. Their faces and legs are white, exceptions merely occurring in the case of individuals in which these parts are dun. The body is very closely covered with wool, which is short

and sufficiently fine for the making of certain cloths. The two shear-wethers, when fat, may weigh, on a medium, from 16 to 18 pounds the quarter, though with great differences, dependent on the natural productiveness of the pastures, and the method of treatment when young. The ewes are usually reckoned to weigh from 12 to 14 pounds the quarter, though with such differences as depend on the nature of the soil and pastures, and the method of treatment. The mutton of these sheep is very good, though inferior in delicacy to that of the Southdown and Welsh sheep, and in flavour to that of the black-faced heath breed. Their natural form is, like that of all mountain breeds, with a light fore-quarter; but this character is removed by the effects of breeding; and the modern Cheviots are of good form. The body is somewhat longer than is usually the case with the heath breed, which has given rise to the popular distinction, in districts where both breeds are cultivated, of long and short sheep. They are larger in the lower countries, where a supply of turnips can be given: they are lighter in the more elevated tracts, where artificial food is scanty or wanting. The breeders adopt the kind of animal which is suited to the pastures, preferring a short-legged larger sheep for the lower farms, and one of lighter and more agile form for the more upland and colder. The Cheviot sheep are of quiet habits, possessing, indeed, the independence of a mountain race, but having none of the indocility which distinguishes some other races. They are exceedingly hardy, their close covering of fine wool enabling them to resist the extremes of cold. They feed more on the grasses, and less on the shoots of heath, than the black-faced breed; and hence they are less adapted to a country of entire heath, and require a larger range of pastures to support an equal number of animals."

The Southdown sheep are indigenous in the downs of Sussex, or at least have existed there from a period antecedent to William the Conqueror, and are one of the purest and most unmixed breeds in Britain. They rank first among the short-woolled sheep, as the new Leicester do among the long-woolled sheep; and, are in pre-eminent request for all sorts of situations to which they are suited in England, and are also cultivated by many noblemen and other extensive landed proprietors both for the quality of their mutton and for their fine appearance in parks. They are most at home on such tracts as the South downs of England, whence they derive their name; and they have, to a considerable extent, supplanted the native races of Wiltshire, South Hampshire, Dorsetshire, Norfolk, and many other districts; and they have also been much used for modifying the native breeds by crossing in North Hampshire, Berkshire, Somersetshire, Cambridgeshire, and other counties; but they are not hardy enough to take the place of the black-faced heath sheep or the Cheviot sheep or the small Welsh sheep or other mountain breeds on the lofty and bleak uplands of the colder parts of the kingdom. Yet, till toward the end of last century, they were little known beyond their native walks in the South downs, and were marked by the undesirable characteristics of a thin chine, a low fore-end, and a rising back-bone; and they were first improved and brought into general notice by the late Mr. John Ellman of Glynde in Sussex, who commenced a course of skilful, perspicacious, and most successful experimenting upon them about the year 1780, and conducted it, with slow and steady effect, during the long period of more than fifty years. Mr. Ellman's own account of an improved South down sheep, except that no spot or speckling on the face can now be endured by good breeders, is still the best description which can be given of the breed:—"The head small and hornless; the face speckled or grey, and neither too long nor too short; the lips thin, and the space between the nose and eyes narrow; the under jaw or chop fine and thin; the ears tolerably wide, and well covered with wool, and the forehead also, and the whole space between the ears, well protected by it, as a defence against the fly; the eye full and bright, but not prominent; the orbit of the eye (the eye-cap or bone) not too projecting, that it may not form a fatal obstacle in lambing; the neck of a medium length, thin towards the head, but enlarging towards the shoulders, where it should be broad and high, and straight in its whole course above and below; the breast should be wide, deep, and projecting forwards between the fore-legs, indicating a good constitution and a disposition to thrive. Corresponding with this the shoulders should be on a level with the back, and not too wide above; they should bow outwards from the top to the breast, indicating a springing rib beneath and leaving room for it; the ribs coming out horizontally from the spine and extending far backward, and the last rib projecting more than the others; the back flat from the shoulders to the setting on of the tail; the loin broad and flat; the rump long and broad; and the tail set on high and nearly on a level with the spine; the hips wide; the space between them and the last rib on either side as narrow as possible, and the ribs, generally presenting a circular form like a barrel; the belly as straight as the back; the legs neither too long nor too short; the forelegs straight from the breast to the foot, not bending in at the knee, and standing far apart both before and behind; the hocks having a direction rather outward, and the twist, or the meeting of the thighs behind being particularly full, the bones fine, yet having no appearance of weakness, and the legs of a dark colour; the belly well defended with wool, and the wool coming down before and behind to the knee and to the hock; the wool short, close, curled, and fine, and free from spiry

projecting fibres." A new and beautiful subvariety of this breed, known as the Babraham Southdowns, was recently raised by Mr. James Webb of Babraham in Cambridgeshire, and has come into great favour.

The Hampshire Down sheep cannot easily be traced to their origin, and seem not to have had any existence till about 60 or 70 years ago. The original sheep of the downs of Hampshire were a large, hardy, long-horned, coarse-boned, unthrifty breed, with tolerably fine short wool, good milkers, and similar in many respects to the old Wiltshire breed; but they are now extinct. The present race seem to have had a mixed origin, and probably arose, in a main degree, from crosses of many of the earliest rams of the improved Southdown race with ewes of the old Hampshire and the old Berkshire races; and they have a larger bulk, a stouter structure, coarser bones, and longer legs than the present Southdowns, and are better adapted for enduring hardships, and for serving some general purposes. The normal form of this breed prevails in North Hampshire; a subvariety of it extends into Berkshire and Wiltshire; and a mixture of it and the Southdown, with a predominance of the blood of the latter, prevails in South Hampshire.

The Lincoln sheep are a long-woolled race, but comprise two very distinct breeds, the old and the improved. The old Lincoln sheep are the most remarkable of the peculiar, coarse, large-bodied family who inhabit the rich marshy tracts of the Fens of England. They are hornless and whitefaced, and have a large tuft on their forehead; their size is bulky, their form coarse, and their bones large; their legs are large and rough; their flanks are hollow, their sides flat, and their carcases thin and weak; their fleece is wondrously heavy, and sends down its long unctuous wool in pendulous masses almost to the ground; and their flesh is coarser, leaner, and less finely flavoured than that of the smaller breeds. But they fatten slowly, and consume much food, and are ill adapted to any system of sparce or artificial feeding; and now they occur within narrow limits, and are hastening to extinction. The improved Lincolns are a cross between the old Lincolns and the Leicesters, and are smaller than the former, and have less wool, and a better form, and a greater aptitude to fatten, and a superior thriftiness of growth, and a better adaptation in every way to the altered circumstances of the husbandry of the plains. "With the new era of agricultural improvement, when the heaths, wolds, and rabbit warrens were converted by the spirited breeders into tillage, arose the great importance of adapting the large unwieldy old Lincolns, hitherto produced for the rich marshes, to the more moderate production of the healthy soils under improvement; consequently rapid advances have been made in their improvement by judicious crosses with the Leicesters; and at the present time they rank amongst the most valuable breeds for the purposes assigned to them, and are shown in great perfection at the great spring fairs of Lincoln, Caistor, Boston, and other places, at each of which full 20,000 lamb-hogs usually change hands, from the heath and wold breeders to the graziers and dealers from the surrounding grazing districts. But they are principally shown in condition for the butcher; and, instead of representing the old coarse breed to be fattened when 2 or 3 years old, they now combine to a great extent the properties of the Leicester, upon a larger scale, with a longer and heavier staple of wool; and in this they have been much aided by the judicious selection of males, from time to time, by the spirited ram-breeders in the different districts in the county."

The Romney marsh or Kent sheep inhabit the low flat extensive fen district on the south coast of Kent, and have extended thence into other parts of that county. The old or native breed were coarsely-shaped long-woolled animals of similar character to the old Lincolns, but smaller. Their head was coarse, and had a tuft of wool; their neck was thick; their chest was narrow; their sides flat, and their bellies large; their limbs were long and stout, and rested on broad feet; and their fleece weighed 7 lb. or 8 lb., and had wool of different qualities on different parts, but in the aggregate moderately soft. They fattened slowly, and, though well liked by the butcher, were unthrifty to the farmer, and consequently passed, in the progress of modern improvement, into general disfavour. The modern breed is a very diversified cross between the old breed and the Leicester; and while some flocks of it exhibit much of the character of the old, and have long legs, flat sides, and coarse extremities, other flocks exhibit scarcely a trace of it, and possess an independent character of much improvement in form, greater disposition to fatten, superior thriftiness in growth, and considerable reduction in size. "Though the pure Leicester ram," we are told, "is now but rarely employed, from the fear of inducing a too great delicacy in the breed, and an inability to withstand the exposure to the weather, and the absence of shelter; yet the present race evidently shows the source from whence it derived its improvement. With the progress of this improvement also there arose a greater disposition to select the most improved specimens for the perpetuation of the race; and the adoption of this principle has, in a great measure, prevented the necessity of returning to the pure Leicester."

The Bampton Notts or Devon sheep are a recently established and very fine breed of long-woolled animals, formed by crossing an old breed on the confines of Devonshire and Somersetshire with the Leicester sheep. The old breed had a white face, a coarse clumsy form, a thick hide, and a long and heavy fleece; and, though difficult to fatten, they weighed at two years of age

from 30 lb. to 35 lb. per quarter. They were called Bampton Notts, from the village of Bampton, and in contradistinction to a race of small-bodied, brown-faced, flat-sided, crooked-legged animals in their vicinity, who bore the name of Southam Notts. The present breed are quite free from all the characteristic defects of the old; and though diminished in bulk, are still among the largest sheep in Britain. The farmers of Devonshire are proud of them, and seem to like them all the better for their comparatively great size.

The Cotswold or Gloucester sheep inhabit the Cotswold hills in the eastern part of Gloucestershire. They are a stationary or retrograde cross between an old breed of the same district and the new Leicester. But whether that old breed were originally long-woolled or short-woolled, and whether they became known at a comparatively recent period or inhabited the Cotswold hills from a very remote date, are matters of dispute. Some persons even imagine that they were the origin of the Merino sheep; and others strongly suppose them to have been introduced at no earlier a period than some time in the course of the last century. But whatever were their previous history, the immediate ancestors of the present breed are known to have been larger in body and coarser in form than they, and are said also to have borne a greater weight of wool. The crossing of them with the new Leicesters began about 60 or 65 years ago, and was steadily and sweepingly prosecuted till not an individual could be found unmodified by the Leicester blood. But after a lapse of 30 or 40 years, "the Cotswold breeders began to apprehend that their flocks were losing too much in carcase and fleece, and becoming less fitted for the climate of their native hills; and from that period, a preference began to be given to the native stock; and for many years past, crossing has been scarcely practised, and most of the breeders have been desirous to revert more to the former model of their breed." The present Cotswold sheep are somewhat larger in size, and have the wool closer on the body, than the highest bred new Leicesters; and they are hardier, more prolific, better milkers, and more amply adapted to common treatment; and therefore have they, in many places, become the successful rivals of the Leicesters, both for constituting entire stocks and for crossing with other breeds.

The new Oxford sheep, or improved Oxford sheep, are simply the best or most refined subvariety of the modern Cotswolds, and differ from the Gloucestershire subvarieties mainly in having flesh of a firmer consistency and a finer texture. "They are bred principally in Oxfordshire and the surrounding districts,—particularly in the neighbourhood of Broadwell, Charlbury, and Sevenhampton. They are of large dimensions, and have a great propensity to fatten, arising chiefly from their wide frame, quietude, and open texture of flesh, which is of quick growth, and consequently expands itself more rapidly than many other qualities; but they do not possess that exactness of form peculiar to smaller animals, though they have a better carriage. For many years, the male animals have been eagerly sought after, with a view to increase the size and frame of other long-woolled breeds."

The new Leicester or the Dishley sheep originated in a series of systematic experiments, begun about the year 1755, and conducted by Robert Bakewell of Dishley in Leicestershire. What old breeds he used in these experiments, and in what proportions he employed them, or whether he used some permanently and others transiently, or some predominantly and others subordinately, are matters of mere conjecture and much dispute. He chose to be mysterious; and he managed to make all the sources of his experiments a perpetual secret. The old Leicester breed, who might come most readily to his hand, were large coarse animals, with an abundant fleece and a fair disposition to fatten,—and they possibly contributed not a little to his results; but other long-woolled breeds, particularly the old Lincoln, and two extinct races in respectively Warwickshire and the valley of the Tees, are also conjectured to have been more or less in requisition; and even breeds of widely different characters, especially the Ryeland, the Southdown, and some other short-woolled races, may possibly have lent their aid. But though Bakewell's subjects are conjectural, both the principles on which he worked them into a new breed, and the practices by which he rendered the breed distinct and permanent, are well known. "He perfectly understood," says Professor Low, "the relation which exists between the external form of an animal and its aptitude to become fat in a short time. He saw that this relation did not depend upon size, nor, in the case of the sheep, on the power of the individual to yield a large quantity of wool. He therefore departed from the practice of all former breeders of the long-woolled sheep, who had regarded size and abundant growth of wool as primary properties in the parents. Holding bulk of body, and the produce of the fleece, to be secondary properties, Bakewell directed especial attention to the external form which indicates the property of yielding the largest quantity of muscle and fat, with the least bone and what is usually termed offal. He aimed, too, it is said, at producing the fat on the most valuable parts; but this is merely a subsidiary property, dependent upon general harmony of conformation. Progressively perfecting his animals by skilful selection, he necessarily continued to breed from his own stock, and did not scruple to connect together animals the nearest allied in blood to one another. This system, continually pursued, not only gave a permanency to the characters imprinted on his sheep, constituting a breed, in

the proper sense of the term, but tended to produce that delicacy of form, which experience shows to be connected with the power of secreting fat, and arriving at early maturity, or what may be termed premature age. The system, acted upon for successive generations, tended likewise to render the animals more the creatures of an artificial condition, more delicate in temperament as well as in form, less prolific of lambs, and less capable of supplying milk to their offspring. It cannot be supposed that Bakewell was unobservant of these effects; but he appears to have regarded them as being of a consideration secondary to the property of producing, in the shortest time, the largest quantity of fat, with the least consumption of herbage and other food. That this was the main result at which he aimed, all his practice shows; and his success corresponded with the skill and perseverance with which he applied his principles to practice. His stock became gradually known and appreciated in the country around him; but it was not until after the lapse of nearly a quarter of a century, that it arrived at that general estimation in which it was afterwards held. He early conceived the idea of letting his rams for the season, in place of selling them. The plan was ridiculed and opposed in every way; and it was not until after the labour of many years, that he succeeded in establishing it as a regular system. It is said that his rams were first let, in 1760, at 17s. 6d. each; but this was certainly before his breed had arrived at its ultimate perfection. His usual price afterwards became a guinea, and, in rarer cases, two or three; but the price rapidly advanced with the increasing reputation of his stock. In 1784–5, the price had risen to about 100 guineas for his best rams; in 1786, he made about 1,000 guineas by the letting of his stock; and in 1789, he made 1,200 guineas by three rams, and 2,000 guineas by seven; and in the same year, he made 3,000 guineas more by letting the remainder of his rams to the Dishley Society, then instituted."

The best form of a Leicester ram—according to the description of Mr. Culley, who was one of the earliest and most successful of Mr. Bakewell's followers in the breeding of the new race—is as follows:—His head should be fine and small; his nostrils wide and expanded; his eyes prominent, and rather bold and daring; his ears thin; his collar full from his breast and shoulders, but tapering gradually all the way to where the head and neck join, which should be very fine and graceful, being perfectly free from any coarse leather hanging down; the shoulders broad and full, and at the same time joining so easy to the collar forward and chine backward, as to leave not the least hollow in either place; the mutton upon his arm or fore-thigh must come quite to the knee; his legs upright, with a clear fine bone, being equally clear from superfluous skin and coarse hairy wool, from the knees and hock downwards; the breast broad and well forward, which will keep his fore-legs at a proper wideness; his girth or chest full and deep; and, instead of a hollow behind the shoulders, that part, by some called the fore-flank, should be quite full; the back and loins broad, flat, and straight, from which the ribs must rise with a fine circular arch; his belly straight; the quarters long and full, with the mutton quite down to the hock, which should neither stand in nor out; his twist deep, wide, and full, which, with the broad breast, will keep his fore-legs open and upright; the whole body covered with thin pelt, and that with fine, bright, soft wool. We shall add the characters of Mr. Bakewell's ewes and wedders, which are supposed to have surpassed all others in beauty of form. The head is long, small, and hornless, with ears somewhat long, and standing backwards, and with the nose shooting forward; the neck thin and clean towards the head, but taking a conical form, standing low, and enlarging every way at the base; the fore-bend altogether short, the bosom broad, with the shoulders, ribs, and chine extraordinarily full; the loin broad, and the back bare; the haunches comparatively full towards the hips, but light downwards, being altogether small in proportion to the fore-parts; the legs of moderate length, with the bone extremely fine; the bone throughout remarkably light. The carcase, when fully fat, takes a remarkable form, much wider than it is deep, and almost as broad as it is long, full on the shoulder, widest on the ribs, narrowing with a regular curve towards the tail, and approaching somewhat the form of a turtle; the pelt is thin, and the tail small; the wool is shorter than long wools in general, but much longer than the middle wools, the ordinary length of staple from 5 to 7 inches, varying much in fineness and weight.

The new Leicester breed is, in an aggregate view, better or more perfect than any of the other races of long-woolled sheep; and it has abundantly proved itself capable of imparting some improvement to every one of them by crossing, and at the same time has derived no advantage from any in return, but can be maintained in vigour only by being kept pure, and perpetuated from the best of its own stock. New Leicester sheep, as regards their feeding qualities, are more profitable on rich low pastures than any other sheep whatever; they come earlier to maturity than even the Southdowns,—a new Leicester wether being fat at 22 months, while a Southdown one is seldom as far forward till he becomes a twelvemonth older; and they contain in their carcase a greater amount of dead weight in proportion to the amount of live weight than any other breed,—the flesh and fat being accumulated more externally, and in the greatest degree in the most profitable parts, and in the least degree in the coarse points. Some of the chief disadvantages of the breed, as compared with the characters and properties of other good

breeds, are inferior prolificity, feeble nursing powers, deficiency in bulk of fleece, comparative weakness of constitution, predisposition to inflammatory diseases, and inability to bear exposure to a churlish climate or to inclement weather. These defects, however, are less now than in the days of Bakewell; and, whenever purity of breed is not an object, they can be much reduced or almost entirely overcome by crossing with such other breeds as the Cotswold and the Bampton Notts. "Bakewell was compelled, in a sense, to confine himself to his own stock, and to the blood of one family, in order to preserve that standard of form which he had produced; but from the subsequent multiplication of the new Leicester breed, modern breeders are relieved from all necessity of this kind. They can obtain individuals of the form required from different flocks of the same breed, and need never, by a continued adherence to the blood of one family, produce animals too delicate in form, deficient in weight of wool, and in that hardiness and soundness of constitution, which are even more necessary than the perfectness of individual form, for the safety and profit of the breeder. The sacrifice of the secondary properties which Bakewell did not hesitate to make, was the result of circumstances which do not now exist; and the present feeling of the breeders is to maintain a larger and more robust form of the animals than seemed good to the earlier improvers. Thus, the Cotswold breed of sheep, though far inferior in form to the pure new Leicester, is maintaining a successful rivalship with it over a large extent of country; the lowland Gloucestershire, the Devonshire, and many of the Lincolnshire agriculturists, are propagating a larger race than is approved of by the Leicester breeders; and even in the north of England, where the Leicester breed was early established, a heavier race is preferred to the purest of the Dishley stock."

The Management of Sheep.—Some of the general and most important points in the right management of all or most kinds of domesticated sheep are discussed in the articles Food of Animals, Feeding, Fattening, Fold, Hurdle, Turnip, Grass-Lands, Pasture, Breeding, Crossing, Bathing, Washing, and Shearing; and other points in the right management of groups or classes of breeds are noticed in the articles Salving, Rot, Braxy, Scab, and Fly-in-Sheep. The best special management of some of the hardiest or least improved breeds is either so simple or so much beyond the control of advice, as not to require any mention; and that of the breeds most generally cultivated in either the uplands or the plains of good sheep districts, though varied according to the habits of the several breeds, and diversified in adaptation to differences of circumstances and of design, and though subject, in most instances, to considerable conflict of opinion or variation of practice among both eminent scientific agriculturists and intelligent, experienced, practical farmers, yet does not require to be detailed in the case of each breed, or with reference to each class of climates and circumstances, but may be sufficiently indicated by short specimen instances to enable any tolerably reflecting young farmer to infer all the details which may be most proper for his flock and farm. The specimen instances which we shall select have reference to the Black-faced, the Southdown, the Lincoln, the Cotswold, and the Leicester breeds.

The black-faced sheep of most districts are merely reared on their native pastures, and then sold to farmers in lower situations who keep them till the age for fattening, and then sold to graziers and farmers on the plains or in the valleys who prepare them for the butcher by means of rich grass lands and artificial food. The ewes receive the rams about the latter part of November; so that the lambs are not dropped till the season becomes open and mild. The flocks are sometimes overwhelmed by severe snow storms; yet they usually receive no artificial supplies of food on their lofty, bleak, sparce pastures than a little coarse hay, sparingly given them at times when they cannot possibly find access to the natural herbage. The ewes are often very weak at the lambing season; and yet they support their lambs well. About the beginning of July, all the full-grown sheep are made to wash themselves by leaping into a stream or pond and swimming to the opposite bank; and, in a few days after, they are shorn; and in the end of October or the beginning of November, they are smeared or salved. On some farms, all the young sheep, while in the state of hoggs, except such as may be wanted to supply the place of the old ewes, are sold; and on others, they are kept till they arrive at two or three years of age. In some farms, also, particularly in somewhat low-lying districts, or with considerable intermixtures of good meadow or arable land, the supplies of artificial food and the alleviations of suffering from the severity of the weather, are far ampler than in the great majority of mountain farms. The winner of a premium at the Edinburgh wool competition in 1845, reports as follows respecting his treatment on a farm in the vicinity of Moffat, of from 910 to 1,550 feet of altitude above the level of the sea, and whose lower parts are enclosed, well-sheltered, and arable: "For the greater part of the year, the sheep are entirely confined to the upper division, or steep ground. The pasture is short and of a bright colour, intermixed with coarse bent, which requires to be burnt in spring. Some years ago, part of the benty ground was ploughed, heavily limed, and sown with grass seed; and thus a great improvement was effected, the bent having been replaced by a bright green pasturage, which cannot be distinguished from those portions of the ground that are not naturally covered with

bent. In winter and spring, the sheep, if their condition seems to demand it, are admitted into such of the lower parks as have been cut for hay, or pastured during the summer by the dairy stock, which is then fed in the house. The sheep are let down from the higher ground in the morning, but are invariably put out of the parks between one and two o'clock in the afternoon. In the event of a severe snow-storm, they are fed with meadow-hay, which is carried out to them. In weaning the ewe-lambs intended for stock, they are put into one of the parks for a week, and then allowed to return to their mothers, whom they recognise, but no longer attempt to suck. An advantage of this plan is, that the lambs follow their dams through the winter, and, if there is snow, they are helped by them to scrape, so that they do not so often need to be fed with hay as when they are kept separate all the winter."

The management of the Southdowns varies with the nature of the district or farm, with the size of the flock, with the subvariety or quality of the sheep, and with the resources or particular husbandry system of the owner. On the true down farms, not only in Sussex, but in Hampshire, Wiltshire, and Dorsetshire, the old practice was to keep them almost wholly on the hill pastures during the day-time throughout the greater part of the year, and to fold them on the arable land at night, and give them there an allowance of hay, at least in the months of winter, and sometimes in most months of the year; and the newer practice, after the introduction of the turnip husbandry, and the consequent enlargement of the flocks correspondingly to the increased supply of winter food, was to treat the old sheep in the same way as before, and to devote the turnips to the support and the prolonged feeding of the young sheep; and the expedients for meeting the common exigency of the exhaustion of the turnips by about mid-winter or the destruction of the remains of them by the frosts of January, previous to the period when the Swedish turnip was brought into cultivation, were, in general, either to make reservations of autumnal grass in the manner of 'fogging,' or to find large supplies of hay, or to regulate or diminish the size of the flocks according to the prospects of spring-feed. The practices of the present day are necessarily far more diversified, and range from an imitation of the old system, or from the mere giving of hay in winter and a few Swedes after lambing, to almost any degree of complication arising out of the improved systems of mixed and rotational husbandry, particularly in the supply of artificial green food for both winter and summer, and of several valuable and prolific kinds of winter-growing crops for spring-feed. The most common artificial supplies, in aid of the native pastures, or in joint-use with them, or in substitution of them, are sown grasses, tares, vetches, turnips, Swedes, mangel-wurzel, cole, rye, and mustard. But, in all the native upland districts and characteristic pasturing-grounds of the Southdowns, they continue to be appropriated specially to downs, heaths, and thin arable soils, and are still more or less dependent, throughout a great part of the year, on the scanty produce of these sheep-walks; and they are, in consequence, treated from lambing-time onward in methods of peculiar adaptation to the circumstances of the farm or district. "In these situations, they are sent regularly to fold, with the exception of those put out for fattening. It was originally the plan to keep the wether sheep with the general flock, and allow them to go to fold until drafted for the London market; more recently they have been divided, and fed at a much earlier age,—many are fatted at the age of 16 or 18 months. With some breeders, who have good meadows and other advantages, the ewes and lambs are not allowed to go to fold, their system being to force their lambs forward for the September fairs, when they fetch exceedingly high prices; others under less favourable circumstances send them to fold regularly, and sell their lambs in a lean state at the same period, that being the season at which the great transfer between the breeders and feeders takes place. Of late years, they have also found their way into the more distant counties to be fatted upon the turnip-soils. The ewe trade has also materially increased, they being sought after for the purpose of crossing with the Leicester or other long-wools; they are then included with the general flock, rarely or never being sent to fold, and they make great improvement. When mixed with other breeds, they are found to produce more lambs, and give more support to them, but to produce less value of wool and to consume more food."

The management of the Lincoln sheep is very much diversified and complicated, and varies according to the subvariety, the district, the general design, the special husbandry, and some particular circumstances. The mode of feeding and fattening the store-flocks depends entirely upon the soil and situation in which they are kept. No breed of sheep vary more in their character and management, from the circumstance of their being bred to suit the marsh-land or the arable districts. The flocks suited to the former districts are most commonly bred in the north and north-eastern parts of the county, and possess more the character of the old style of Lincolns. The breeders of this description of sheep make it their study, in setting their flocks, to select those females that possess the longest wool, strong bone, and largest size, their leading object being to raise a thick-fleshed, hardy animal, suitable to their soil and climate, which, from its coldness during the spring months, is only considered suitable for lambs coming rather late in the season. Their plan of management during the lambing season

varies but slightly from the Leicester, with the exception of their having good grass reserved to place them upon after lambing. The lambs are allowed to remain with the ewes until the 1st of August; and they are then placed upon clover eddish, and subsequently upon coleseed, and are finished with cut swedes. Corn is rarely given in this district. The study of the breeders is to turn out large long-woolled lamb-hogs for the purpose of grazing, when, unless sold to the graziers, they are run very thickly upon their clovers, or middle descriptions of grass-land, during the summer. From the bleakness of the district, they are not shorn until the beginning of July; and, as these breeders and graziers look more to quantity than quality of wool, it suits their system. During the month of August, the flocks are thinned out to other parts of the farm; and afterwards they are placed in their winter-quarters on the best grass-land for fattening. When they are intended to be sold in March or April, they are allowed from half a pint to a pint of old beans per day, that kind of food being best in their cold situations. On the rich or warmer lands, they attain a sufficient degree of fatness without any artificial food, and are also sold off about May. With the graziers they are replaced with lamb-hogs at the late fairs, which is an excellent arrangement. Those shearlings that have been kept back upon the second-rate grass-lands are put forward amongst the beasts on their rich pastures during the summer; thence they go to coleseed, and subsequently they are sold to the butchers in the neighbourhood, being far too heavy for the London trade, as at this period of the year they weigh from 30 to 36 lbs. per quarter upon an average. The sheep bred upon the heath and in the middle of the county are the improved Lincolns; and their management is closely assimilated to the Leicester, particularly upon the heaths near Lincoln. With the addition of their spirited husbandry in supplying them with artificial food throughout the year, the universal plan of these breeders is to sell their lamb-hogs in the spring from turnips; consequently every movement is brought to bear upon the production of first-rate fat lamb-hogs, whereby an immense return is made in the shape of wool and mutton, as also in the succeeding crops of barley, seeds, and wheat. The effect of sheep-husbandry on the productiveness of the soil is an important feature in the general rules laid down upon the heath-farms; for, as the soil requires artificial aid, so does the importance of producing sheep at an early age become essential. By constant attention to an equal and proper distribution of the flock fed upon artificial food, immense results follow, it being better to spend a portion of the money set aside for artificial manure in the purchase of oil-cake, &c., to be passed through an animal to the soil, thereby gaining a second return, than to expend the whole amount in the production of vegetables. Again, such are the propensities of the best sheep to fatten, that an ample return of wool and mutton is made for the extra keeping allowed them, and the land is manured at a cheap and easy rate. Further, by the use of artificial food, the vegetable produce is much economized, the animal is kept longer upon the land, and becomes more healthy and less liable to disease. The breeders upon the heaths and wolds rarely occupy grass land, but generally plough their whole farm, and merely procure a portion of marsh land at a distance and use it for growing or feeding the cattle raised on their ploughed farm. In setting their flocks at Michaelmas, they select ewes who are uniform in size, frame, fleece, and style, and use only rams who, in addition to being well-proportioned, possess what they call 'good looks;' and during the lambing season, some of them feed their ewes upon mangel-wurzel, and find it to suit much better than turnips. The wether-lambs of the principal breeders are preferred to the ewe-lambs, and separated from them at an early period; and when taken off about the middle of July, they are still supplied with corn or oil-cake upon the seeds; and afterwards are placed upon the turnips; and, in the barley-thrashing season, are indulged with bruised barley and malt-comb along with oil-cake; and as the spring advances, receive cut swedes in addition to other artificial food. Some breeders prefer keeping their lamb-hogs until the late fairs, and allow them to take the best of their young seeds; others reserve them entire for the ewes that are suckling the couples and wether-lambs. In some instances, the lambs are not castrated until the first week in August, to produce extra size and constitution, when they are either castrated, or what is termed "trapped," and are rarely known to falter or decline eating their food after the operation. The ewe-lambs are drafted early in the winter, and the culls placed with the wether-lambs to be sold in the spring,—the best being reserved for the flock, and kept entirely upon turnips. The flock-ewes are inspected and drafted early in the summer, and are removed from their lambs about the first week in June, when they are prepared for the autumn fairs, and fetch high prices, breeders from the surrounding districts being anxious to procure them. In the southern or Grantham district, the wether-lambs are kept upon moderate food during the winter, it being the practice to sell them as shearlings in the autumn, when they are purchased by the graziers for wintering upon their grass-land, or for feeding off coleseed, where the land is intended to be sown with wheat.

The Cotswold sheep are kept principally on the hills and on circumjacent poor, thin-soiled, arable tracts; and they require to be managed on principles of good sheep-husbandry. The breeders produce their sheep at an early age; and the best flock-masters rarely practise fold-

ing. In setting the flocks, particular attention is paid to size, wool, strength of constitution, propensity to fatten, and uniformity of character and carriage, by which the animals are easily distinguished from other long-woolled breeds. The ewes are placed with the ram rather early in the season; and care is taken to have a reserve of fresh keep to remove them to about the middle of September. The rams are continued with the ewes about nine weeks; and during the latter part of this time, they are kept upon white turnips, and thence they are drawn out weekly upon the plan adopted by the Leicester breeds. Great attention is paid to the flocks during lambing-time, the yards being made very warm and comfortable. The wether-lambs are put forward and managed upon a similar plan to those upon Lincoln Heath; but the Cotswold breeders are more particular in having early spring feed for them. They are supplied with corn, according to circumstances, through the summer. When the clovers are going off about midsummer, they are frequently removed to green tares provided for them, the ewes being taken away and placed in some distant field. When the lambs are placed upon the tares, they are either allowed fresh pens from time to time, as they require them, or the tares are mown and given them in racks, or laid alongside the trays to be eaten through them. The better plan, when consumed upon the land, is to have a regular set of iron trays, upon feet, coupled together by rings and staples. These trays should be 12 feet long, upon oak feet 2½ feet long, which may be moved in an onward direction several times a day, according to the consumption through them. By this plan the tares are much economized, and fed off without being in the least degree soiled. These iron trays, being portable, are equally good for feeding off coleseed upon the same principle, and are much used for this purpose in South Lincolnshire, where it is not uncommon to see coleseed much higher than the sheep, particularly in those situations where paring and burning is practised, and the seed drilled in with a portion of bones. When the feeding of tares is practised to any extent, they are sown at different intervals during the spring, to hold out until after harvest, at which time the lambs are removed to the barley stubbles, or young seeds, and are supplied with white turnips thrown upon the land for a short time. They are placed upon the turnips at the end of September, and commence their winter management with cut turnips and artificial food, which is increased during the winter. About March and April, they are sold fat to the butchers in the neighbourhood, or sent to the London market. Those breeders who bestow less care and expense upon their lamb-hogs, sell them in a store state at the principal fairs in the neighbourhood, to be fattened by the graziers. The breeders, in fact, make it their practice to clear them off when the turnips are finished. The flock-ewes are drafted and sold upon the plan adopted by the Lincoln-Heath breeders.

The new Leicester sheep require to be reproduced on principles which will secure the purity of the breed, and promote, in the surest way, the prolificity of the ewe. All the best breeders are very fastidious about the sound blood and the good points of both rams and ewes, and promptly reject animals who, though otherwise exceedingly good, possess some little deteriorating cross or deteriorating tendency, or want some little uniformity in their general outline; and some reject the entire produce of any ewe or set of ewes who have in any degree disappointed them, and are exceedingly cautious in using young sheep who have not been proved, preferring to see their produce in order that they may proceed with the least possible risk of defect. Ewes who have been selected for breeding are, for some time, kept in better fare than the rest; and groups or classes of them are studiously assigned to such rams as are best suited to correct their faults. The method of many breeders is to admit the rams early in September for forward lambs, and about the first of October for the general stock of lambs; but a much better one, now generally practised by the most successful breeders, is to place "a teazer" with the ewes, and to bring them individually and regularly out as they are observed. When the office of the ram is over, the ewes are dressed with mercurial ointment, in the proportion of 2 lbs. to the score, to cleanse them and to assist the growth of the wool. On grazing farms, the ewes, up to this season, and in many situations much longer, are kept upon the grass or meadow lands; but on arable farms, which contain but a small proportion of grass land, they are usually placed upon the turnip lands, to pick up the leavings of the store-lambs, who are allowed to go forward,—and they do exceedingly well. But a fortnight or so before lambing, they are drawn out and placed upon grass land, if possible, near home; they are shut up every night in a lambing-yard; a few turnips are thrown to them in the field when convenient, otherwise they are allowed a moderate quantity of corn, with cut hay or clover chaff; and when suitable, they are placed upon turnip-lands for a few hours during the day, exercise being very desirable. Those that have lambed during the day or night are removed to convenient sheds previously prepared for the occasion, and thence to better quarters, such as a prepared field of rye, or rye and tares mixed with a little coleseed, but more commonly to young seeds or grass-lands which have been rested for them, and there supplied with a few turnips or corn. Upon arable farms, it is frequently their lot to be again placed upon the turnip-land, with a supply of rock-salt to lick in small iron troughs. Salt is also frequently given with the chaff. In those situations where the

breeder has no arable land, which is the case on a great many farms in Leicestershire, the ewes are placed with the ram at a comparatively late period in the season; and are fed entirely, or almost entirely, upon grass throughout the year. It would be better, however, to supply them with a moderate quantity of corn during the spring or lambing-season, as they are then frequently so much reduced, as to cause great loss during the lambing-time, besides stinting the quantity and quality of wool, and occasionally making the dam, offspring, and fleece, all culls. In the case of a ewe losing her lamb, it is customary to place the skin of her offspring upon another lamb intended to be put with her; and the ewe generally takes to the stranger in a short time; but in the event of difficulty, a little gin rubbed upon the skin of the lamb and nose of the ewe at once effects the desired object. Upon turnip and seed-farms, where the design is to raise fat wether lamb-hogs, the management of the lambs is commenced at an early period. They are promoted in regular succession, being first separated from the ewe-lambs and allowed to take precedence throughout the year. It is now the practice to wash and shear the general flocks in the beginning of June; though this is considered by some too early in the season. By this plan, they are found less subject to fly-galls, gain more weight during the summer, and have a more bulky appearance when sold in the autumn; and there is no difference in the weight of wool, if adopted as a general system. The custom of dipping the lambs directly after the ewes are shorn is a valuable one, and should never be omitted. There is also a growing practice of having the whole flock dipped at this period of the year, as it affords an excellent opportunity for cleansing them. The lambs are again dressed with mercurial ointment in the first week of October; if this be omitted, they are much tormented during the warm spring months. The weaning of lambs is considered to be a nice point, as much depends upon its being properly accomplished. The plan of taking the ewes from their lambs to a distant field reserved for them, rather than taking the lambs from the ewes, is preferred; for the lambs being accustomed to their pasture, remain more quiet than when removed to a strange field, where they fret, become thin and exhausted with bleating, and too often incur fever and scouring, which are the forerunners of other diseases, and the cause of their doing badly for weeks, if not the whole winter following. The ram-lambs are put with their dams into the clover or reserved spots for some few days previously to weaning, where they learn to eat green tares, which are found invaluable by those breeders who use them for a start. Lambs should never be placed upon rested summer-eaten clover pastures, however tempting they may appear, as they invariably cause scouring, fever, and other severe ailments. Old grass, clover, or grass-eddish is preferable until the autumn quarter commences, which is considered an important one, as much depends upon the manner in which the lambs are started, or taught to eat their winter food. In the middle of September, the lambs are placed in moderate lots upon grass or seeds, as, from the domestic habits peculiar to the race, they are fond of picking their food at this season of the year, cabbages being thrown to them upon the pastures, or cut for them in troughs; and after a short time, a few white turnips are mixed with them, as a preparation for the winter. As October advances, they are placed upon the common or white turnips. Some breeders mix a little coleseed in the first sowing, and find it an excellent plan. After a short time, the wether-lambs receive each $\frac{1}{4}$ lb. of oil-cake, or corn to that value, per day; and at Christmas, they are placed upon the swedes which are cut for them,—as are also the white ones upon bad layer. As the spring advances, the oil-cake or corn is increased according to circumstances, whether the animals be intended at once for the butcher, or are to be kept until midsummer, or even later. The ewe-hogs are kept entirely upon turnips and cut clover-chaff, with plenty of salt. When the turnips are finished, the ewe-hogs are placed upon moderate grass-land or old seeds. When the wether-lambs are reserved for fat shearlings, they are placed upon the young clovers to commence their work, and are sold by some breeders about August or September, to make room for the lambs. Other breeders prefer to keep fewer ewes, and keep their shearlings on until the following spring, when they are again shorn and sold to the butchers in the neighbourhood, being too heavy for the London trade. In this case, the lambs are never separated at an early age, but are kept together until 14 months old. In many parts of Leicestershire, the lambs are wintered upon grass only, and are frequently sold fat as early as the following August and September; though some breeders keep them over until the next spring or midsummer. It is the practice with some to draft their ewes at the age of three years or three shears, and place them with a horned Dorset or Southdown ram, for the purpose of feeding what is termed 'lamb and dam.' In this case, the ewes are usually sold in high condition at the Leicester October fair, and are much sought after by different breeders from the adjoining counties. At this fair, a considerable trade is carried on in the sale and letting of rams, it being the conclusion of the season; but the leading breeders prefer 'letting' their sheep at home, which commences on the 8th of June, and continues during the season.

Protection for Sheep.—The affording of protection to sheep, in cold and exposed districts, is one of the oldest and most general of the practices which man has found necessary for the preservation and improvement of his flocks; and

it has varied, in both kind and degree, according to the severity of the climate, the nature of the pastures, the comparative hardiness of the breed, and the comparative enlightenment and resources of the age and country. Six chief kinds of protection are at present available in Britain; and two or more of them, in many situations, are capable of being combined. One is a simple modification of the natural shelter afforded by great or abrupt inequalities in the surface of the pastures; another is the raising of plantations or of stone or turf walls; a third is the constructing of stells, cotes, and other erectional retreats for the flocks; a fourth is the salving or smearing of the bodies of the sheep; a fifth is the covering them with pieces of cloth in the manner technically called bratting; and a sixth is the encouraging of such a variety of fleece as, while of undiminished value for the market, will render the sheep, in a main degree, self-protected. The third of these is noticed sufficiently in the articles Fold and Sheep Stells; the fourth, sufficiently in the articles Salving; and the second, partially in the article Shelter; —so that, in this place, we need only to glance at the second, and to take brief though sufficient notice of the first, the fifth, and the sixth.

Plantation, especially when aided by walls or turf fences, affords excellent protection from storms of wind, rain, and snow; for sheep will always run to it in the time of need, and are always safe while under it. But, in almost all cases, it requires to be produced at the expense of the landlord; for, though a tenant should have a lease of even 19 or 21 years, and should plant at the very commencement of it, in the best way, on the best land, and with the most rapidly growing trees, he could not possibly get shelter enough for his flocks before the expiration of the lease to compensate for his outlay,—and would get no winter shelter whatever for a considerable proportion of the years. The side or quarter of the pastures on which every sheltering plantation should be raised is that where the greatest number and greatest force of storms prevail throughout the year. The trees most suitable, in very exposed situations, are the mountain-ash, the Scotch pine, the beech, the hawthorn, and the oak, with the larch as a temporary nurse. The amount of plantation, on the very bleak uplands, of a somewhat champaign district, or on the moorlands or subordinate ranges of a highland or alpine district, ought not to be less than half an acre at the distance of every mile or every three-fourths of a mile or every half a mile; for if sheep, when overtaken by a storm during the night, do not know of shelter within less than half a mile, they will not leave their lair to obtain it. The best form of plantation, in a glen and extending from the hill to the bottom, is the belt or oblong; but the best in most other situations, particularly on a plateau or on a slowly declining slope, is the square,—and this is greatly aided by a rood of turf wall or of any similar erection running diagonally from each corner.

Modification of natural shelter must vary according to the nature of the ground, and may either be very slight or very considerable according to circumstances. A few sheep farms have such an abundance of dry ravines and abrupt heights, in excellently sheltering directions, as scarcely to need the aid of any planting or building or other similar appliance; and very many or even most possess enough of natural inequality of ground to be easily converted into valuable or sufficient protection by means of pieces of wall and clumps of plantation at the most defective points. Where there is much natural shelter, the first consideration ought to be, whether the ground is dry or wet; and if wet, it ought to be immediately drained; for so long as it is allowed to remain in a wet state, it is altogether unfit for shelter. A judicious store-farmer, by availing himself of the natural inequalities of his ground, and erecting here and there a few roods of turf wall or coarse stone wall, according to the curvature and exposure of the surface, may, in most cases, double the amount of 'beild' at a very trifling expense.

The "bratting" of sheep has been long known, but, till of late years, was rendered a very questionable or a too expensive method of protection, in consequence of the accompaniment of salving, the high price of cloth, and the want of skill in adjusting the brats. The expense of combining salving with bratting was inconveniently great; and the practice of sewing the brat to the wool was at once costly, troublesome, and inefficient, —and very often resulted in the tearing of the fleece, the loosening of the brat, and the tormenting of the animal. But salving—at least in the old and expensive forms of it—can now be greatly modified; cloth is now cheap; and an easy and effective method of adjusting the brat is now practised. "Substances have been discovered," says Mr. MacTurk, in the Transactions of the Highland Society for 1843, "which completely obviate the necessity of smearing, at not more than a half-penny per head, or one-tenth the expense of smearing. Cloth, very well suited for the purpose, may be made from the refuse wool of carpet manufactories, equally thick and warm as a blanket, and this can be got for 6d. per yard. If cloth, such as sacks are made of, be employed, it may be had for 4d. per yard. When intended for bratting hogs, it should be three-quarters wide; and two feet of such cloth will be sufficient for covering one hog. When intended for old sheep of the best description, the brats may be made larger by applying the cloth the long way, and we have then 27 inches of width to cover the back and side instead of 24, and it can be cut off as long as the largest sheep will require. The brat should always come as far down the sides as to cover the widest

part of the ribs, and all the back, from the tail to the back of the neck. The best plan is to select a sheep from the flock, of an average size, and measure the quantity of cloth required for it. When the cloth has been applied to the animal, and its proper dimensions ascertained, the parts should then be marked to which the different straps and strings are to be sewed to hold it in its proper place. A strap must then be fixed to one of the front corners, in a diagonal direction, so as to pass beneath the throat, and sewed to the other corner after it is put on, in the same way as the other straps which are intended to pass through beneath the legs; these must be sewed only at the one end, till the covering be put upon the sheep, and then the other end can be sewed so as to make the brat fit. These straps should be of some soft material, that they may not chafe or injure the skin when the sheep is in motion. If, when made, the brats are dipped in coal tar, it will enable them the better to resist the wet, and prevent them rotting. If taken care of, they will answer the end for five seasons. They ought to be made early in summer, in order that the tar may be dried before the time of using them arrives in November. They ought not to remain on the sheep any longer than the beginning or middle of April, according to the state of the weather and the condition of the flock at the time. We recommend that considerable care should be bestowed in attaching the strings to the proper places in the one first made, so that it may fit well, as it is to serve as a pattern to make the others by. A person who is accustomed to the use of the needle will make one in five minutes, and it may be put on in less than other five. A brat of woollen cloth with the string will not cost more than 5d.; and one of the flaxen ones about 3½d.; but the former will last longer and answer the end better. In order to prevent them being stolen, and to enable the shepherd to distinguish the flock under his charge, they should be all marked with the buisting iron dipped in white paint. Some days before the brats are put on for the winter, the sheep must be poured with some one or other of the bathing mixtures to destroy vermin. Some days after this process, when the wool has regained its usual appearance, the brats should be put on; and the mode in which we recommend this to be done completely obviates the inconveniences arising from the method which has hitherto been practised of sewing it to the wool; for it will be observed that it is wholly attached to the body, and not to the wool, and it therefore possesses this decided advantage over the old method, that it cannot be rubbed off, while, at the same time, it preserves the wool from being so, in case of the pile getting weak from disease or from low condition. When the brat is taken off in April, the wool will be found to have retained the yolk, and will appear quite yellow. When examined, it will be perceived to be sappy and sound, and quite free from the defect that wool staplers call hasky and pinnay, (*i. e.* dry and brittle,) which occasions much loss in the manufacture. When washed, its natural whiteness is quite unimpaired, we would even say increased, from the soap which had been used in pouring, and the yolk which is retained."

The choice and encouragement of a self-protecting fleece is only ancillary to other means of protection in cold and exposed districts, but is of very considerable value in such, and serves as a complete means in low or comparatively warm and genial districts. "Of the varieties of fleece which are preferred," says Mr. MacTurk, "we shall notice first the long, loose, open, lingly fleece which has been gaining ground for the last ten years; and, next, the close fleece, which, 20 years ago, was more generally in request. The only advantage which the former description of fleece possesses over the latter is, that it gives the animal a more showy and bulky appearance, particularly in dry weather, when the piles are tossed about by the wind; but when wet it does not possess even this slight advantage, but, on the contrary, gives the animal a more comfortless appearance than the less showy but more close and serviceable fleece. The same partiality for the long and open fleece prevailed for a time among the breeders of the Leicesters; but the error has been discovered, and now no breeder of any note of that description of stock will lift his voice in defence of it; and there cannot be a doubt that a few years' more experience of it, particularly if the winters are severe, will convince the breeders of black-faced stock of the impropriety of the preference. Indeed we have never met with any store-farmers who will maintain that the open fleece will enable the animal to maintain its condition equally with the close one. The latter, in wet weather, retains the globules of rain upon the top of the fleece, till the animal shakes them off; and it is only in very heavy showers that the fleece allows the rain to penetrate to the skin; but before the open fleece is charged with rain, a shed or opening is formed all the way along the back of the animal, and the rain is thereby allowed at once to find access to the skin, along the surface of which it is conducted; and it cannot then, as in the former case, be shaken off. The same objection applies when there is a fall of snow; but the evil in this case is of a more aggravated character; for the shed in the fleece along the back is often filled with snow for a whole day together. Now is it possible that anything could be more injurious to the health of the animal, or more likely to occasion disease, than that one of the most vital parts of the system, namely, the spine, along which the circulation is conducted, and from which the nerves emanate, should be thus so frequently exposed to the chilling influence of wet and cold for days together? There

is another very serious evil attending the kind of fleece in question, namely, that after the snow has fallen, the ground drift prevails to a very formidable extent; and it is from this kind of drift that the store-farmer has to apprehend most danger to his flock, inasmuch as in nine cases out of ten it is by the rieves of snow thereby accumulated that his flock is overwhelmed; and although the drift may not prevail to a very alarming extent, yet, as the animal seeks food or shelter, or in any way alters his position with regard to the storm, or as the wind swirls from one inequality of the surface of the ground to another, or as the animal encounters a different current of the blast, one part of its loose fleece is lifted after another, and thus every where the snow and wind find access to the skin, till each portion of the fleece is drifted full of snow. It must then, I think, be evident to every one how much these circumstances tend to endanger the life of the animal; and I affirm that a close fleece is better adapted for retaining, in winter, the amount of condition acquired in summer, and the sheep possessing it are thereby a degree in advance in spring. It is contended, on the other hand, that the more open fleece is, in general, longer in the pile, and, therefore that it will yield a greater clip, and that the high prices which have, of late years, been obtained for wool, sufficiently justify the preference which has been given to the sheep which yield it. My experience has led me to an opposite conclusion, and I have almost invariably found that the little additional length which is sometimes found in the more open fleece, is more than counterbalanced by the greater number of piles in the close one, and their superior fineness." See the article Wool.—*Cuvier's Animal Kingdom.—Bewick's History of Quadrupeds.—Bingley's British Quadrupeds.—Jardine's Naturalist's Library.—Pennant's British Zoology.—Parkinson on Live Stock.—Culley on Live Stock.—Baxter's Library of Agricultural Knowledge.—Bourgonne's Travels.—Young's Annals of Agriculture.—Sir John Sinclair on the Different Breeds of Sheep.—Pallas on Sheep.—Low's Domestic Animals.—Spooner on the History and Diseases of Sheep.—Youatt on Sheep.—Rham's Dictionary of the Farm.—Communications to the Board of Agriculture.—The Quarterly Journal of Agriculture.—The Journal of the Royal Agricultural Society of England.—The Transactions of the Highland Society.—Anderson's Recreations in Agriculture.—Hunter's Georgical Essays.—Buel's Farmer's Instructor.—Dickson's Husbandry of the Ancients.—Dr. Dickson's Practical Husbandry.—Young's Farmer's Calendar.—Napier's Treatise on Practical Store-Farming.*

SHEEP-COTE. See Fold and Sheep-Stell.

SHEEP-FOLDS. See Fold.

SHEEP-MAGGOT. See Fly-in-Sheep.

SHEEP-PENS. See Hurdle.

SHEEP'S BEARD,—botanically *Arnopogon.* A genus of hardy, ornamental, yellow-flowered, herbaceous, exotic plants, of the succory division of the composite order. Two annual species and a perennial have been introduced to Britain from the South of Europe; and a biennial from the Cape of Good Hope.

SHEEP'S FESCUE. See Festuca.

SHEEP-SHEARING. See Shearing of Sheep.

SHEEP'S-SCABIOUS,—botanically *Jasione.* A small genus of ornamental herbaceous plants, of the bellflower order. The mountain sheep's-scabious, or common sheep's-bit, *Jasione montana,* abounds on the sandy pastures and dry heathy grounds of Britain. Its root is annual; its herbage is rough with short rigid hairs; its stems are either simple or branched and from 4 to 15 inches high; its leaves are sessile; and its flowers grow in a terminal tuft or head, and have a fine blue colour, and bloom in June and July. Two perennial-rooted, evergreen, blue-flowered species,—the dwarf and the perennial, the former about 6 inches high and blooming from June till September, and the latter about a foot high and blooming in June and July,—have been introduced to Britain from France, and are well adapted for ornamental rockwork.

SHEEP'S-SORREL. See Sorrel.

SHEEP-STELL. A place of retreat and security for sheep during the prevalence of a mountain-storm. It differs from every kind of fold in being, not simply a place for feeding, but principally an asylum from danger. Stells are exceedingly various in size, form, material, position, and appliance; and they must, in a general view, have just the construction and character which will best suit the exigencies of each particular farm. But a very common and very good one is simply a circular wall, about 30 feet in diameter, about 6½ feet in height, on dry ground, on as level a spot as possible, in such a situation that the drifting snow may be expected to be carried clear of the pasture, and accompanied, on one side, with a hay-yard of about 21 feet by 15; and such a stell is specially efficient when a large enough plantation extends on the weather side of it to break the force of the prevailing winds, and when a wall of two roods in length is attached on the side opposite the hay-yard. A set of structures like this will well serve for eight scores of sheep; and should stand on a part of the farm to which the flock naturally resort in winter. When flocks are large, a comparatively large number of stells at comparatively small distances, all about the size which we have indicated, are very greatly preferable to a lesser number at wider distances. No hollow should intervene between any stell and the adjacent hill or acclivity; for a hollow in such a position is liable to be filled with drifted snow at the very outset of a storm, and may in consequence arrest the retreat of the flock from the hill to the shelter. A circular form of stell is preferable to any other form for winter protec-

tion, on account of its seldom affording permanent or injurious lodgment to snow; for, when any considerable degree of wind prevails, no sooner does the snow come within the wall, than it is elevated by the whirling blast or current which sweeps the enclosure, and is carried over the wall and thrown out; and even when no wind blows, and when the snow lies and accumulates steadily where it falls, the sheep within the stell always keep above it, and have been known, in a case of heavy and long-continued fall, even to raise themselves upon the accumulating deposit to the very level of the wall. Some persons, however, prefer winter-stells in the form of the letter T, or in that of the letter H, or in that of the letter S, or in that of various lines and curvatures expressly adapted to the special configuration of the ground; and others have attempted, with more or less success, to combine the properties of winter-stell and summer-stell by means of a complex form of projecting enclosures and intermediate recesses,—the former for retreat from snow-storms, and the latter for shelter from hurricanes. But summer-stells are wanted in different situations from the winter ones, and do best within or near the brow of hills, in spots to which the flocks most frequently retreat from the fury of the blast, and may consist only of a semicircle or two transverse walls on a declivity, or of three walls diverging from a common centre on the top of a knoll, or of a single line of wall on the wing of a cliff or precipitous escarpment. See the articles Fold and Shelter.

SHEEP-WALK. See Pasture.

SHELL. A hard, close, cubical envelope, either natural or artificial. The word is used in very many and widely different senses; but it concerns a naturalist or an agriculturist principally in the sense of the hard, calcareous coat of birds' eggs and of the bodies of molluscs and crustaceans. A shell, in this sense, is a mineral substance, with some intermixture of animal matter; and, when properly used, acts readily and richly as a fertilizer of the soil. Egg shells consist principally of carbonate of lime with some magnesia, but comprise about one per cent. of phosphate of lime and magnesia, and from two to four per cent. of animal matter; the shells of molluscs have a compact texture, an enamelled surface, and sometimes splendid variegation of tint and outline, and consist almost entirely of carbonate of lime, with layers of coagulated albumen, or with a soft animal substance similar to gelatine; and the shells of crustaceans contain a large proportion of carbonate of lime, a considerable proportion of phosphate of lime, and a quantity of cartilaginous matter similar to coagulated albumen. The comminuted shells deposited by the tides or embedded in the bottom of bays and estuaries, form both an abundant and an excellent manure. See the articles Sand and Shell-Sand. Large quantities of entire or partially broken shells, whether obtained from natural deposits or accumulated artificially, may be prepared for prompt manurial action either by pulverization or by calcination; but though, in the latter way, they fall readily to powder, they are liable to sustain a wasteful loss of their animal matter. See the articles Oyster and Animal Manures.

SHELL-LAC. See Lac and Coccus.

SHELL-SAND. A natural mixture of sea-sand and comminuted shells. See the article Sand. "The shell-sand of our coasts is often obtained in the state of a fine powder; and in that form it acts better than in a coarser form, and the same weight goes farther. But none of it is so fine as the powder to which slaked lime falls. It has, therefore, occurred to many that it might be rendered more valuable by a partial burning. The shell-sand which is collected on our coasts contains a variable proportion of sea-sand. This sometimes is as little as 5 or 10, but at other times it amounts to as much as 50 or 60 per cent. of its whole weight. This variation will, of course, affect its value as a manure in whatever state it is applied. In consequence of this admixture of sand among the shells, it will unavoidably happen, during the burning of them, that in those parts of the fire or kiln where the heat is greatest, a portion of the sand and lime will occasionally melt together, and form a silicate of lime. So much of the lime as has thus been converted into silicate, will, of course, be less immediate in its action upon the soil, although it will be by no means without an ultimate good effect. When mixed with the soil, it will by degrees be reconverted into carbonate, and will at the same time liberate a portion of silica in that soluble state in which, in some soils, it may possibly promote the growth of the corn crop and strengthen the straw. This roasting or burning of the shell-sand has been tried with success in Cornwall. By burning it has been found to become so brittle as easily to be reduced to a fine powder; and in this powdery state, it has produced on several farms, a marked increase in the crops of roots and corn. This was of course to be expected, especially on cold undrained lands, and such as were naturally poor in lime. The native shell-sand would have produced the same effects in a less marked degree. Ordinary lime shells, newly fallen or slacked, would have produced a fully equal effect. This method of burning the shell-sand, therefore, though it greatly inproves it, does not give it virtues which other lime does not possess." [Report of the Agricultural Chemistry Association of Scotland.]

SHELTER. The sheltering of sheep is treated in the articles Sheep, Sheep-Stell, and Fold; the sheltering of cattle is noticed in the article Feeding of Animals; and the sheltering of fields and pastures and tracts of country is disposed of in the articles Plantation, Enclosure, Fence, Wall, and Hedge. In this place, therefore, we

shall merely point out, in a general way, the effects of shelter, with the view of inducing all classes of landowners and land-cultivators to appreciate and promote it; and this we cannot better do than in abstracts from a series of able papers on the subject, by Mr. Donald Bain of Edinburgh, in the Quarterly Journal of Agriculture.

"Of all things," says Mr. Bain, "shelter would seem a subject that need only be mentioned to recommend itself in a country such as this. In regard to the natural body, we admit at once the value of this system. In regard to that body, indeed, three things in particular are required, — dryness, warmth, and sufficient food. Of these three things, the last, or food, is, of course, indispensable to existence; but are not dryness and warmth nearly equally so? Nay, with dryness and warmth, the individual may live and enjoy comfort with even insufficient food; but no extent of food could preserve him in health, or even from death, without dryness and warmth. It is so with the earth, and with all the fruits of the earth, and all that live upon it and them. In countries naturally cold, all animals destined to live in them are endowed with suitable coverings, excepting man; and he borrows from the earth and from other animals, and in the coldest country surrounds himself with the temperature necessary to his comfort, or he does not prosper. He has only to consider this condition of his own existence, to see at once what he ought to do for any plants or animals he may find it profitable to rear; unless, indeed, we should rather import a climate from other countries, as well as corn and cattle. In particular instances, we already pay attention to shelter, in regard to the plants of the garden and hothouse, and the animals of the menagerie; but as a general principle, and in regard to those plants and those animals it is most important we should care for, we are most recklessly and unphilosophically negligent. Yet this is like being wise in trivial matters and neglecting the weighty points of the law; we care where we are compelled to care,—where without care the plant or the animal would die; but to all short of this we are indifferent, though policy and humanity alike dictate conduct entirely opposite. If fields of corn or flocks of sheep only occasionally perish from want of shelter, though, as a general matter, they *all but* perish, we are contented; we put up with the loss as an effect of climate instead of an effect of negligence; we endure the loss instead of preventing it, and suffer it to be deducted from income when we might add it to it. We do this from habit and heedlessness; yet it is not one bit wiser than it is in the savages of western America to construct themselves mounds on the banks of rivers to which to run when the floods come, and die from famine, so far as they escape the waters, instead of embanking the rivers, as the inhabitants of Holland have done even by the sea. Year after year the savages perish, of course, in thousands, and have their health destroyed to the extent of many thousands more by flood and famine, and the pestilence consequence on both; yet they are untaught, and being now nearly confined to those regions, they will speedily die out, and consider it a natural necessity of their situation; whereas we see that there is no natural necessity in the case, but that they are merely unteachable. And, year after year, we have crops wasted and cattle starved from want of shelter, and flocks of sheep buried in snow or carried away by every paltry burn, because there are no proper residences for shepherds to attend them, and no food or shelter to which to drive them on the coming on of floods or storms. To all this we submit, and deduct for such probable casualties from the rents agreed to be paid, instead of removing the casualties; and landlords know and suffer this, though there would be nothing easier than to prevent it. Is not this admirable management? Passing over the inhumanity to the people employed, and the animals thus called into existence to be destroyed or starved, is it not barbarous in an economical point of view? What should we think of a general who should thus suffer his army to be decimated, when by proper care he might prevent it?—of a farmer even, who, by neglecting the precautions he has agreed to consider necessary, should allow his crops to be wasted by frost, or his horses by want of stabling? Yet the want of any degree of shelter to crop or stock, that in its results would overpay the cost, is just as barbarous as any of the cases I have supposed.

"There is little doubt that, from imperfect shelter, there is not only a direct general loss from death or non-production, but also a waste of food to cattle and of manure for the fields, to an amount scarcely to be calculated. We may easily be satisfied of this by general reasoning, without the test of experiments; for what is the use of shelter? and what are its effects? Its use, as vegetable life is concerned, is very various. We are all now aware that vegetation derives its principal nourishment, not from the earth, but from the air,—from the dews that are constantly falling from the heavens, and the gases that are ever evolving in or rising from the earth, assisted, of course, by the proper temperature produced by the sun and earth. Well, how can a blade of corn, or of any crop, imbibe the necessary nourishment from dew or air, or enjoy a healthful existence, or even live, if perpetually scourged by petrifying winds? Can we expect anything to prosper in such circumstances,—having neither food, nor warmth, nor rest? We cannot. We see, in consequence, whole fields of the most promising crops, in one night or day, scourged into dry and withered blades, or smitten to blackness from unbearable cold. These crops may recover if the malignant influence shall not

be continued too long, as a man or animal may recover from incipient consumption; but is not the constitution of both tried and their existence perilled? and if these trials and risks might have been prevented, ought they not to have been so?—Again, why is the grass always greenest or the crop most luxuriant by the side of a shelter? It is not because most manure has been applied there, for very probably no manure whatever has been applied there. But suppose equal manure to have been applied, still the question remains, Why is the crop there both strongest and greenest? It is because there you will see the dew resting, like silver, on every spike, affording its nourishment undisturbed, like a mother nursing her infant in some nook sheltered from the wind, and only exposed to the sun, and soft and gentle air. To such a corner the hardiest animal is happy to repair, to feed or ruminate, even in the kindliest season; how much more when the cold and blighting wind is raging and the tempest of rain or snow? And these cold winds rage with us much too often, especially in spring, when both plants and animals require most to be sheltered from them. But if in spring shelter is necessary, it is not less expedient in every season, as not only averting disease from plants and animals, but effecting a vast saving of food and energy to both. I have lately read, in a most respectable English Journal, the result apparently of some experiments on the very subject on which I have been reasoning. They are headed, 'Effects of Cold and Heat in Fattening,' and are abridged as follows:—'It is well known that cattle do not fatten so well in cold weather as in hot. The reason is this. The fat is a highly carbonized substance, formed by animals from their carbonaceous food. In cold weather, the carbon in this food is consumed in keeping up the heat of the animal, which is at that season more rapidly carried off. This is also illustrated in an experiment made by Lord Ducie at Whitfield. One hundred sheep were placed in a shed, and ate 21 lbs. of swedes, each, per day, another hundred were placed in the open air, and ate 25 lbs. of swedes per day, yet, at the end of a certain period, the sheep which were protected, although they had a fifth less food, weighed 3 lbs. a-head more than the unprotected sheep. The reason of this,' it is continued, 'is obvious: the exposed sheep had their carbonaceous food consumed in keeping up their animal heat,'—that is, as he has mentioned, from being carried off by the air; as it is long since it has been established, that a man would lose more weight from being exposed without covering, by exsiccation, than he would in the same time by perspiration, though in the warmest dress. 'Warmth,' continues the reporter, 'is thus seen to be an equivalent for food,'—meaning, in this case, to animals, but I say also to plants; and to both the result is from saving of waste. 'This is also established by the fact that two hives of bees do not consume so much honey when together as when separate, on account of the warmth being greater. Cattle, from the same reason, thrive much better when kept warm than when exposed to cold.'

"We have, therefore, thus established, at one and the same time, at once the direct advantage and the economy of warmth; for warmth is not only productive of health and strength to the animal, but these at a greatly reduced expense of food. Hold the advantage or saving to be only 20 per cent.,—and, from the experiment quoted, it is shown to be greatly more; and what an immense sum would this be, spread over the flocks and herds maintained by pasture in these kingdoms? There is another view,—the loss of sheep, and lambs in particular, from casualties, including want of warmth; and, from a distinct record of this description now before me, kept by an intelligent shepherd for 17 years, the mean annual loss of old sheep or hoggs is 20¾ per cent., or upwards of one-fifth! and this without reckoning the loss of lambs, estimated also at 20 per cent.; or converting the lambs into sheep, raising the per centage in general to 27 per cent. And this last estimate has reference to a southland farm. What the losses are on the unapproachable hills, and in the chasms and gullies of the west and north, has never, perhaps, been attempted to be shown; but, in their present neglected condition, it may be conceived.—And as gainful as warmth is in the case of animals, it is certainly also in the case of plants,—perhaps more so. For though in plants also we find the strong stem can with more probability recover the effects of a blight, it, at the same time, suffers by it with more intensity, and requires, consequently, a corresponding waste of food and energy to recover it, that is, of manure and of sun; which last, though costing no direct expense, is the last thing that should be wasted in this climate, because, in this climate, such waste is ruinous.—And what so contributes to warmth as shelter? What so completely economizes the heat both of the earth and of the sun? And how does it economize both, and the dews and gases they evolve between them? By preserving them from being swept away, and by allowing them to be generated in the greatest quantity and of the highest temperature. If we will only walk in the street of a city exposed to the sun, we shall have a perfect example of how the heat is economized and the temperature increased. From reverberation it becomes at last painful, if combined with a moderate degree of calm. In the neighbourhood of a wood facing the sun, or in an enclosure formed by shelters of moderate height, the illustration is both more pleasing and more complete. There the heat is less reverberated. It is absorbed by the earth, and rendered at once more genial and less oppressive. But a moderate degree of heat, thus economized, is indeed of the utmost utility. The

air that, between the gases evolved from the earth and the dews that had been deposited from the clouds, may be termed medicated to the plants that require its nourishment, is not wasted, is not swept away, or dried up; neither is it scorched or rendered stagnant; but, by moderate shelter, is rendered duly warm, and applied in quiet; and the plant and the animal alike enjoy the genial influence. In short, by shelter we create a climate; and is it necessary to say anything more?

"There is hardly a spot in Scotland, nor, of course, in England, or Ireland, that might not be rendered of a kindly temperament by shelter. It is not absolute height that renders our plains and mountains cold,—it is merely relative height; that, being the highest, and unsheltered by anything higher, the air passes over them unchecked and unmitigated, and, acquiring strength as it goes, becomes at last scourging and destructive. Upon a surface so swept, the sun can take no effect, nor can the earth impart any warmth; the influence of both is overborne by cold and scourging winds. But where the gale is checked, and the air over any particular spot is rendered tranquil, it soon becomes warm, either from the direct heat of the sun or the latent warmth of the earth. The enclosed space, though on the highest hill, becomes in effect a valley, for it is surrounded by higher objects. Its air becomes attempered, its climate and consequently its soil improved; for it becomes the seat of vegetation, and draws nourishment from the previously idle and scourging air; and the blast that was previously destructive, and, like a marauding army, overrun the space, leaving desolation only behind it, is now arrested, and made to yield, to the very woods that arrest it, the nourishment they need, —is turned from an enemy, levelling all before it, into a subservient drudge, to yield food and water to the hills, as well as to the plains, and enrich where it had previously impoverished. Need I say to intelligent readers that this is no fancy picture? No, for every object around them, and every reflection upon it, will convince them of its truth. The lowest plain, if swept by a scourging wind, is barren, or next to barren, whatever may be its soil; and on the other hand, on the highest hills, if we find a valley, it is fertile, precisely because it is not swept by cold and scourging winds."

"Let any one look at a moor where plantations have been raised, and he will find as follows:—First, if the wood has been properly planted, and fenced, and thinned, that is, if proper care has been taken to make the plant reach the subsoil, to shelter it while growing, and in due time to provide room for its growth, the wood is thriving; and instead of heath, as was the original covering of the soil, it is now covered between the trees by a rich, and if they are close, an exceedingly silky grass. Even the heath at the outskirts, if any remains, has a softer and more luxuriant character than the stunted article of the same description without the enclosure. It may be said this is produced by the manure annually furnished by the falling leaves,—and this *may* promote the richness and luxuriance of the grass; but the efficacy of shelter is evident from this, that the grass is often finest and richest where there is shelter only, and no manure from the falling leaves, that is, in casual openings of the plantation. Next, if corn-fields have been created under shelter of the woods, they will generally be found luxuriant, while beyond this, there is first coldness, and a light crop,—and beyond this perhaps heath; or even one side of the wood is thin and stunted, and the other, which has been sheltered by this stunted part, is thriving and vigorous. A more remarkable evidence of the benefits of shelter, and of the consequences of the want of it, may be stated as follows:—where a dyke has been raised of a certain height, and trees planted within it, the trees are cut by the blast as if by a hedge-knife, exactly in the direction the blast has received from the coping of the wall; that is, if the wall is flat at the top, the wood has suffered far in; if the angle of the top is small, the cut of the trees is exactly of the same angle, and extends far in, in proportion to the flatness of the angle; but if the angle is very acute, and sends the blast almost directly upwards, the wood almost escapes,—the tree by the wall is slightly cut, and no more. These facts may not have been noticed in any scientific publication, but they are open to every observer; and they suggest many ideas of the utmost importance, as regards this division of the empire. They suggest, first, the great utility of shelter as a general principle; next, that where woods are planted, the wall opposed to the most prevalent or most destructive wind, should be of considerable height; and third, that even the form of the coping of dykes for woods or fields, is of consequence, and that it should always be of such an angle, as to send the blast (which in all cases will obey it more or less), almost directly upwards.

"By proper shelter, almost every part of this kingdom might be brought into a state of warmth and productiveness. Ranges of moor, apparently the most barren, might be rendered warm and kindly to every species of vegetation. Even hills, were it worth while to contend with them, might be conquered by successive belts of wood; and if not cultivated (as they evidently have in many instances been), at least made of double or triple value for pasture. But our common moors and moorland require nothing so much as shelter; and even where the lands are not moorish, but much exposed, shelter is necessary both to the fields and flocks, and nothing can so much enhance their value. And it is not continued ring-fences, clapped down any where, or any how, that should be recommended in this

matter. When an engineer wishes to oppose the tide, he does not put down a long dead wall; he puts down in the strength of the current, a point of great power, and as the strength of the current, thus broken, diminishes, he diminishes his defences, and finally leaves the matter to the tide itself, when fully broken, to the desired direction. In like manner, the person dealing with the winds, should consider where they bear hardest, and where they may be made to trend away with advantage, and suit his defences to the exigency, whether in height or strength. A very slight defence, for example, placed on a height exposed to the east, may not only protect that height, but shelter a long reach of lower land. The whole east coast of Scotland is bold, and it is bare. A belt of wood behind a wall of proper height, and presenting proper angles to the blast, might shelter whole districts inland; and so, of any other exposure, art is in this case, as in most others, greatly more than strength. An hundred yards of wall or of wood, rightly placed, may do more than a thousand placed without skill. Put down without judgment, indeed, intended defences may do manifest injury, for they may shut out the most kindly influences, and expose the crop to a cataract of included winds. But, as a general position, shelter is, in Scotland, of the greatest value; it is nearly a national object; it might reclaim many thousand acres that without it never can be reclaimed, and almost incalculably improve many thousands more. In a recent history of Devonshire, it is said, 'In this part of the country, the fences are chiefly high mounds, surmounted by coppice-woods, which not only afford a sufficient supply of fuel, but also a surplus of poles, cordwood, faggots, and oak-bark for sale. This kind of product is considered a crop of some value, in addition to its utility as a fence; as it affords to the pasturing animals excellent protection from wind and sun, with but moderate care and expense in repairing. These hedges are better adapted to the hilly surface of Devon, than to more level countries, commonly forming altogether a barrier thirty feet high, which so softens the rigour of the unfriendly blasts, that many of the inferior hills are cultivated to the very summits. A stranger unaware of the practice, considers himself as travelling in deep hollow ways, for miles, till arriving at some elevated opening, he is charmed with the delightful scenery of the fertile country he has passed.' This places the principle of shelter on a large scale, so completely on the footing of an approved practice, in one of the counties of England, apparently made 'the finest' by this very practice, that there seems to be no necessity for giving the idea out with fear. The whole of the east coast of Scotland should be sheltered by high mounds, either carrying or protecting wood; and in every situation where the plains or valleys are swept by scourging blasts, similar impediments should be put down. This acted upon as a general principle, for a few years, would entirely change the climate and aspect and even the soil of many parts of Scotland; for as money makes money, so heavy crops lead to heavier crops, by enriching at once the soil and the cultivator, from making more manure, and sheltering and fining the soil. There is no part of Scotland, or England, or Ireland, that may not be sheltered at less expense than the wilds of America may be cleared, and with more certainty of a market for the proceeds. Sheltering leases, therefore, should be granted, as improving leases have been; and speedily we should see shelters rise, as profitable to the raisers, as pleasing and profitable to the country."

SHEPHERD. A person who has the care and management of a flock of sheep. A shepherd in eastern countries and in patriarchal times is a character of intense interest, and forms the subject of many of the most glorious and sublime allusions in the best of books. See the article SHEEP. Even a hill-shepherd, in our own country, at the present day, is, or ought to be, one of the choicest of rural men,—eminent for common sense and country skill, in all matters of ordinary observation, distinguished for wisdom and kindness in the discharge of his immediate duties, and lifted high into the purest philosophy and the most religious devotion by the peculiar influences of his position. Hogg, the well-known Ettrick Shepherd, was a remarkable instance of how the tending of flocks may warm the heart and fire the genius and light up the whole intellect into a luminary; and, in spite of all the doubtfulness and darkness of his higher speculations, even he spake of the mountain shepherd "seeing God in the clouds," and being almost of necessity an intensely religious man. "The daily feeling naturally impressed on the shepherd's mind," said he, "that all his comforts are so entirely in the hand of Him that rules the elements, contributes not a little to that firm spirit of devotion for which the Scottish shepherd is so distinguished. I know of no scene so impressive as that of a family sequestered in a low glen during the time of a winter storm; and where is the glen in the kingdom that wants such a habitation? There they are left to the protection of heaven, and they know and feel it. Throughout all the wild vicissitudes of nature, they have no hope of any assistance from man, but are conversant with the Almighty alone. Before retiring to rest, the shepherd uniformly goes out to examine the state of the weather, and makes his report to the little dependent group within; nothing is to be seen but the conflict of the elements, nor heard but the roaring of the storm; then they all kneel around him while he recommends them to the protection of heaven; and though their little hymns of praise can scarcely be heard, even by themselves, as they mix with the roar of the tempest, they

never fail to rise from their devotions with their spirits cheered and their confidence renewed, and go to sleep with an exaltation of mind of which kings and conquerors have no share. Often have I been a sharer in such scenes, and never even in my youngest years without having my heart daily impressed by the circumstances. There is a sublimity in the very idea. There we lived, as it were, inmates of the cloud and of the storm; but we stood in a relationship to the Ruler of these that neither time nor eternity could efface."

A shepherd requires no small amount of perspicacity and kindness and general excellence for the discharge of even his proper duties. "Much of the success in sheep-farming," remarks Mr. Little, in his Practical Observations on Mountain Sheep, "depends on the skill and application of the shepherd. As his situation is one of considerable trust, he ought to be honest, active, useful, and of a calm temper; for if at any time a shepherd gets into a passion with his sheep, it is attended with great disadvantage in herding, or in working among them. The qualification required in taking care of a hirsel, (or flock,) is not in running, hounding, and training dogs, or in performing a day's work of any other kind; but to direct them according to the soil, climate, and situation of the farm, in such a manner as to obtain the greatest quantity of food at all seasons of the year. Their health and comfort should be carefully looked after by the shepherd; and if his exertions are made with judgment, they are of very great consequence to the farmer. It is not by walking much, and doing a great deal, that a shepherd is a good one, but it is knowing where to walk so as to disturb the sheep the least, and by doing at the time whatever is necessary to be done. There is not an experienced shepherd who has been any length of time on one farm, who does not, as soon as he rises in the morning, and observes the state of the weather, know almost to a certainty where to find every sheep on the hill, and will accordingly take his course to the places he knows his presence is most wanted. The object in looking over a hill every evening and morning, is to ascertain if there be no trespassers nor diseases among the sheep which require looking after. If any of your own or neighbour's sheep have trespassed, it is very foolish to dog or abuse them; for the more gently you can turn them back the better. If the boundary should be on the top of a height, to which sheep are apt to draw at night, it is better to turn your own a little closer to the boundary in the afternoon, than to turn back your neighbour's,—and it will answer the same purpose; and if the two flocks are gently divided in the morning, without dogs, they will become so well acquainted with their own side, that at the very sight of the shepherd, they will take to it without farther trouble. Those shepherds who dog, force, and shed much about a march, I consider them as bad herds for their masters as for the neighbouring farmer. When a sheep dies on the hill, or any disease appears among them, the dead or diseased sheep should be removed immediately, but particularly so if the disease appears of an infectious nature. Looking regularly over a hill is of great consequence, also, in case of any sheep falling into a ditch, or a lamb losing its mother, or when they are annoyed by flies or maggots, or by foxes or dogs worrying them, or when they fall on their backs and cannot get up again. Knowing sheep by headmark often saves a shepherd much trouble, particularly in the lambing season, and at all sortings of the sheep; yet there are many good shepherds who do not know sheep by headmark, and there are some very ordinary ones who have a talent in that way. Every individual may be known by the stock-mark. To possess the knack of counting sheep readily is of no small service to a shepherd; for he ought always to be able to count his flock when he makes his rounds on the hill. There are few shepherds who accustom themselves to count sheep, who cannot, whenever they meet with them on a hill, count 100 going at large, or even 200; and it seldom happens that a greater number than 200 will be found together in an open hirsel. To know the number in the different lots is of great use in case of a hasty blast, as you can, in that event, know almost to a certainty, whether or not any sheep are awanting, and from what part of the farm. A shepherd ought likewise to be able to do any kind of work about a sheep-farm, such as cutting lambs, smearing, slaughtering, dressing for the market, repairing stone-dykes, cleaning out drains, mowing grass, making hay, casting and winning peat-turf for fuel, &c.; but he ought at no time to neglect the sheep for such work."

SHEPHERDIA. A small genus of hardy, ornamental, North American shrubs, of the oleaster family.—The Canadian species, *Shepherdia canadensis*—called by the old botanists *Hippophae canadensis*—was introduced to Britain in 1759. It closely resembles the common sea-buckthorn in general appearance, and attains about the same height, and has nearly the same dark brown colour of bark on its branches, and blooms at the same period, but may readily be distinguished by its oval-shaped leaves. It thrives in any common soil, and may be propagated from suckers, layers, or cuttings.—The silvery species, *Shepherdia argentea*, abounds on the banks of the Missouri, and was introduced to Britain in 1818. It commonly attains a height of from 10 to 14 feet; and is highly esteemed for the silvery splendour of its foliage; and may be readily propagated from layers; but is of slow growth, and sometimes of a very dwarfish habit. Its leaves are petiolate, entire, oblong-ovate, obtuse, smooth, and covered with peltate silvery scales; its flowers, as also those of the preceding species, are

dicœcious, and apetalous, and bloom in April and May; and its fruit are diaphanous, scarlet berries, with a pleasantly acid taste. This species loves a soil of peaty loam.

SHEPHERD'S CLUB. See Mullein.

SHEPHERD'S CROOK. A cylindrical iron rod, peculiarly bent into a narrow hook-like form, and mounted upon a long wooden shaft. It is used for catching sheep, and serves the purpose well in dexterous hands; but requires to be employed with great caution by a novice.

SHEPHERD'S DOG. See Dog.

SHEPHERD'S NEEDLE. See Scandix.

SHEPHERD'S PURSE,—botanically *Capsella* and *Thlaspi*. Two genera of herbaceous plants, of the cruciferous order.—The common shepherd's purse, *Capsella bursa-pastoris*—called by Linnæus *Thlaspi bursa-pastoris*—is an annual weed of road sides and similar situations in Britain and in most other countries of the world. Its root is tapering and whitish and has a smoke-like odour; its herbage is rough with hairs; its stem is branched, leafy, and from 6 to 20 inches high; its radical leaves are deeply pinnatifid; its flowers are corymbose, small, white, and often tinged with purplish brown, and bloom from February till November; and its capsules are inversely heart-shaped and somewhat triangular, and contain about 5 seeds or upwards in each cell. The flowers and seeds are eaten by birds. Four very distinct varieties, besides the normal plant, occur wild in Britain,—the smaller, the apetalous, the entire-leaved, and the buckthorn-leaved.—The corn shepherd's purse or penny cress, *Thlaspi arvense*, is an annual weed of the corn fields of Britain. Its stem is 6 or 8 inches high, and its flowers are white, and bloom in June and July.—The alpine shepherd's purse, *Thlaspi alpestre*, is a perennial-rooted weed of the meadows and pastures of some parts of England. It has a height of about 6 inches, and carries white flowers from May till July.—The perfoliate shepherd's purse, *Thlaspi perfoliatum*, is a biennial weed of the stony grounds of some parts of England. It is also about 6 inches high and white flowered, and blooms from April till July. —Five or six exotic species of Thlaspi have been introduced to the botanical collections of Britain; and 8 or 9 more are known.

SHERARDIA. See Field-Madder.

SHERDS. Fragments of earthen pots, used in gardening for under-draining gravel walks, and for forming a drainage stratum beneath the soil of potted plants.

SHIELD-FERN. See Aspidium.

SHIFT. See Rotation.

SHIM. See Plough.

SHINGLES. Pieces of thin board, used for covering roofs in the manner of tiles and slates.

SHOCK, or Stook. A small stack of sheaves of corn, set up in the field as soon as the corn is cut and the sheaves are bound, in order that they may dry. Eight or more sheaves are set on end in pairs leaning against each other; and two or four, called hoods or heading sheaves, are laid horizontally over them, by way of roof or covering to protect them from the weather. The size and form and constructing of shocks vary in different districts. Never more than ten sheaves are allowed to a shock in many parts of England; but so many as twelve or fourteen are common in the best parts of Scotland. The constructing of shocks is generally neater and more efficient in Scotland than in England.

SHOEING. The artificial surface upon which the horse is made to tread in the performance of his labour—roads and pavements of various descriptions—requires that his feet should be furnished with some artificial defence; otherwise, his hoofs would speedily wear away, exposing the quick or sensitive parts of the foot, and rendering him so lame as to be perfectly useless. In some countries—in the sandy deserts of Arabia, for example—no such defence is said to be requisite, at least for ordinary purposes; indeed, even in our own country, we may ride some horses for weeks and months together, with only sufficient shoe to cover the toe of the hoof, the part most subjected to friction and fracture.

Whatever kind of shoe is used should consist of such material and be made of such a form as to interfere in the least possible degree with the internal mechanism and functions of the foot, at the same time that it serves every purpose of defending the hoof. A shoe made of any elastic or yielding material, possesses many advantages over one of an opposite description, because it allows of the expansion and contraction of the hoof; but every such shoe is found by experience not to be adequately substantial and durable. A leathern shoe would hardly last for a single journey; and even if it were durable, it would want resistance sufficient to guard against fracture of the hoof. Iron, therefore, has almost universally become the material employed; and although manifold alterations and some improvements have taken place in the form and construction of the shoes, iron, in some way or other, is still the substance of which all are made.

The toughness of the hoof and the strength of the crust afford a ready means of attaching the shoe; but as this must be effected by means of nails, and as these must be continued round a considerable part of the hoof, the crust becomes firmly fixed to the shoe, so as almost entirely to prevent the natural and necessary expansion and contraction of that part of the hoof; and as the action of the whole depends in a considerable degree upon the individual parts, a general derangement of the whole foot is a necessary consequence of the interruption of these functions. It must have appeared, on the first application of a shoe, that it was necessary to allow a degree of freedom to the motion of the horny sole, because constant firm pressure on it, even in the strongest feet, will produce lameness; con-

sequently the earliest and the most rudely constructed horse-shoe that we find for the fore feet, was formed so as to admit in a certain degree of the motion or descent of the sole. But it was afterwards found, as more particular attention came to be paid to the diseases of the feet, that many of the rarer or more deep-seated of these arose from the means adopted to prevent the more obvious. The simplest and readiest method of preventing pressure upon the sole, by allowing its descent, was to bevel off the shoe in such a manner that the crust of the hoof could only rest on the outer edge of it; thus leaving a sufficient space for the descent of the sole. Such a construction, however, involved the foot in more serious consequences. The sides and extremities of the crust, resting upon an inclined plane, when the animal is made to perform the ordinary exertions to which he is commonly applied, are made to approximate each other at every step; and, instead of the liberty of action, and the expansion of hoof which would take place in the natural and unrestrained state, the foot becomes so squeezed as to occasion great pain to the animal, and to involve a total destruction of its own functions. Connected with shoeing, arises another inconvenience, in the gradual growth of the hoof, which, exposed in a state of nature, is constantly being worn away, but, by the protection of the shoe, becomes abundant, and requires to be cut down more or less at different periods. The paring of the hoof being of necessity entrusted to those who apply the shoe, and they viewing the operation as an indifferent matter, a careless and improper removal of the hoof is almost a certain consequence, by which means parts that ought to be left strong and well protected are removed, while those which ought to be removed are commonly allowed to remain; and, in consequence, the feet become distorted, and disease is rapidly induced.

Amongst the first who attempted to remedy these defects was La Fosse, who considered the principal evils to arise from the construction of the common shoe raising the heels and frog from the ground, so as to deprive the tendons, when in action, of the necessary support which they receive from the frog in a state of nature resting upon the ground; and to obviate these mischiefs, he strongly recommended the short thin-heeled or half-moon shoe, extending round the toe, and back to the quarters, and to leave the sole and frog unpared. The heels and quarters being thus left at liberty, and the frog brought in contact with the ground, the foot somewhat approaches the natural state. But, while this shoe may be applied with safety and advantage to strong feet, the varieties that occur, both in the form and strength of different feet, and in the construction of the limbs of many horses, set narrow limits to the advantages that were at first expected to arise from its adoption. The tendons of the limb, instead of being relieved by it, seemed to suffer more frequently than before, because the elongation of the toe by the gradual growth of horn, and the addition of the shoe upon frequently an improperly prepared foot, threw a greater instead of a less strain upon the tendons, more especially in long pasterned horses, and thus a formidable objection to it was raised, which, together with its obvious inapplicability to very low weak-heeled feet, prevented it from passing into permanent repute.

Osmer, J. Clark, and Moorcroft, considering that the evils produced by shoeing arose chiefly from the bevelling of the shoe, improper paring, and unequal pressure, introduced and recommended the seated concave shoe, now most commonly in use in the most respectable forges in this country; and the fact that it has continued to be generally approved, notwithstanding many more modern attempts to substitute something better, is almost enough to establish its superiority over at least the majority of other forms of horse-shoes. A properly made seated shoe is formed nearly of an equal thickness on its outer edge, from the heel to the toe. On the surface next the hoof, a portion is left quite flat for the crust to rest upon, which flat part is continued all round the outer edge of the hoof surface, but is, at each heel, the full breadth of the shoe for the junction of the crust and bars to rest upon. By this means, the hoof which rests upon it is not squeezed or inclined in, as in the old plan of shoeing; nay, at the extremities of the heels, it may be so arranged, that, instead of inclining the crust inwards, it may be bevelled off, so as to form an inclined plane outwards, and thus assist in expanding the foot. After sufficient space is left for the resting of the crust, the remainder of the web (the inner part of the shoe) is bevelled off, so as to leave a space, when the shoe is put upon the foot, sufficient to allow a picker to pass freely all around between it and the horny sole. By this arrangement, the shoe is tightened, and a flat or even a concave surface may be exposed to the ground, by which the animal's step is rendered secure. To preserve the shoe safely in its situation, it is pierced with either seven or eight nail holes for a moderate sized horse, and with a greater number for larger ones. These holes are generally pierced from a groove, technically termed the fullering, made in the ground surface; and though they may be stamped at once without affecting the merits of the shoe, yet the fullering both enables the shoe to take a firmer hold of the ground, and, when properly executed, serves as a guide to the proper placing of the nail-holes. The advantages of the seated shoe, however, great though these are, have been found insufficient to prevent a number of the most serious diseases of the feet, such as chronic founder, contraction, and grogginess.

Professor Coleman, at the commencement of his career, adopted the opinions of La Fosse; and, by a variety of ingenious contrivances, for several of

which he took out patents, he long continued to support them. Finding, at an early period, more difficulty in the practical application of the short shoe than in the principles of it, he chose to make the heels of it extend to the extremity of the crust, at the junction of the bars, keeping the heels sufficiently thin to allow the frog, under ordinary circumstances, to receive a degree of pressure; but as this could not always be obtained, he invented an artificial frog, an iron wedge, of sufficient thickness at its posterior part to extend beyond the level of the shoe, and rest on the frog; so that when the animal stood in the stable, he should by this means rest the whole, or the greater part, of his weight upon the frog. From this it was expected that the foot would become expanded, and contraction be prevented. The shoe, however, after a time was found insufficient to effect these purposes; and, in addition to the thin heels and wedge, clips were added, which were made to press against the junction of the crust and bars, and thus to offer a mechanical obstruction to the contraction of the hoof. But the friction arising from the elasticity of the heels, soon allowing these clips to insinuate themselves into the horn, prevented those advantages which were first expected from them; and to aid this again the heels of the shoes were now bevelled outwards, so that the hoof, resting on this inclined plane, was forced asunder, as it were, at every step.

The frog-bar shoe was next tried; and this, in its various forms, by keeping up continued pressure upon the frog, was expected to have the power, not only of preventing contraction, and removing it when it had taken place, but also of proving a complete protection to weak heels, and a preventive of corns, thrushes, sand-crack, false-quarter, canker, and the like. But, instead of affording the ease or protection expected from it, it proved in many cases a cause of some of the very diseases it was intended to prevent.

The spring-heeled shoe, or the grasshopper, as some London veterinarians wittily called it, was next tried. This differs from the common shoe in being bevelled off towards the heels, on the surface next the hoof, from the quarter to the extremity of the heel; and at the commencement of the slope in the quarter, there is a steel spring, welded or rivetted on, and continued to the heel, so as to form a continued plane with the surface of the hoof. Between the extremity of the spring and the thinned part of the heel of the shoe, a space of about three-eighths of an inch is left; so that when the weight of the posterior part of the heel falls on the spring, it is allowed to descend, and a degree of liberty is thus afforded. "While I agree with the principles upon which this shoe is applied," says Professor Dick, "I do not altogether agree with the construction of the shoe itself. The advantage to be derived from keeping the heel easy, or springing the heel of the shoe, has been long known to working farriers, and such a process has been found to afford relief in many of the evils of the foot. It is effected in two ways,—either by bending the shoe a little from the hoof at the point of the heel, or by cutting away such a portion of the horn as to prevent the heel of the shoe and the heel of the hoof from coming in contact; and in this latter state it will remain, and retain its situation, until the proportion of the hoof is altered by the progress of growth and the friction between the hoof and shoe. Such an adaptation of the common shoe seems to possess all the advantages, without the complexity, of the spring-heeled shoe, namely, keeping the heels easy, assisting in preventing corns, and affording liberty and elasticity to the heels; and where, from the weakness of the quarters, the common shoe cannot be properly supported, it can in almost every instance be obtained by the bar-shoe. But where the frog is much diseased, and both heels and quarters weak, the spring-heeled shoe may be found of service."

The jointed or expanding shoe came into use contemporaneously with the several and successive inventions which followed the introduction of the seated shoe; and it promised for some time to do wonders, but has already passed into almost total desuetude. It is either seated or concave like the common shoe, and has a joint at the toe for permitting the natural expansion of the foot. But its nails, if well fixed, render most of it perfectly inflexible, and cause the joint to act only as a sort of useless hinge; and, if ill fixed, occasion special stress on the crust at the holes, and become loosened, and tend eventually to tear portions of the crust away. A really expanding shoe, on the jointed principle, should have many joints, in a series along the sides and quarters, and would be at once too complicated, too costly, and too frangible for general use.

The unilateral shoe, or shoe of one-sided nailing, was invented by Mr. Turner of London, and possesses some very decided advantages over even the best forms of the concave seated shoe, and has already superseded it in many of the best forges. It is fastened with five nails along one side; and has two clips,—the one in front, and the other between the last and the next-last nail. "This shoe," says Youatt, "is identified with the grand principle of the expansibility of the horse's foot, and of removing or preventing the worst ailments to which the foot of the horse is liable. It can be truly stated of it, that while it affords to the whole organ an iron defence equal to the common shoe, it permits, what the common shoe never did or can do, the perfect liberty of the foot. There can be no doubt that the one-sided nailing has been exceedingly useful. It has, in many a case that threatened a serious termination, restored the elasticity of the foot, and enabled it to discharge its natural functions. It has also restored to the foot, even in bad cases, a great deal of its natural formation,

and enabled the horse to discharge his duty with more ease and pleasure to himself, and greater security to his rider."

Rodway's patent shoe was invented to suit the slippery surface of the wooden pavements which began, some years ago, to be formed in parts of several of the chief towns of the kingdom. It is simply a concave-faced shoe, whose concavity is constantly filled with dirt, and presents so rough a surface to the pavement as to prevent slipping.—Powell's patent shoe was invented for the same purpose as Rodway's, but presents a sharp surface to the pavement.—If horses had constantly to tread such surfaces as those of wooden pavements, they might go without shoes altogether, and enjoy more ease and safety than with the very best shoes which can possibly be contrived.

The shoes of any common kind for the hind feet are stouter at the toe and straighter at the quarters, than those for the fore feet, and, in general, have also the heels turned up to form calkins.—The common hunter's shoe is cut considerably shorter at the heels, and allows less intervening space between its seat and the foot, than the ordinary seated shoe.—The three-quarter shoe wants the inner heel or quarter, and is suitable for a horse when turned out to grass, or otherwise withdrawn from treading a hard surface.—The tip shoe wants both heels, and is used for the same purpose as the three-quarter shoe, and was formerly used also for racers, but has been superseded in the latter application by a light shoe called a plate.

The French method of shoeing has long been much extolled by some British veterinarians; and, in some respects, with reason enough,—in others, more, it would appear, for the sake of fashion and novelty than real advantage. The French shoe is rather broader in the web than the old English one; it is equally thick at every part; the foot-surface of it is concave, the ground-surface convex, and curved upwards at the toe, in order to give the limb, what the French call "the adjusting balance." Altogether, the shoe itself is certainly, in many respects, an objectionable structure; and in no respect is it more so than in the curvature which is given to the toe of it, the principle of which is false, unnatural, and injurious. The French mode of nailing the shoes upon the feet, however, is one deserving attention, both from the facility with which it is practised, and from the preservation which it affords to weak, brittle hoofs, which, by our method, are too frequently done injury to. The holes in the French shoe are punched in that direction which (instead of penetrating the crust longitudinally—in the direction of the fibres of the wall, as is the case in English nailing) gives the nails an oblique direction, forward as well as upward, by which they not only get a stronger hold, but a more secure one, and are more certain in their issue, —their points making their exit but a little way above the shoe itself; and this method of nailing is not confined to the French, but prevails over all the Continent.

The Persian, Turkish, and Arabian shoes, bear a common resemblance to one another. A horse-shoe of these countries consists of a thin plate of iron, which is said to be hammered into form without being heated. It has a small circular hole in the middle, but for which it would entirely cover the lower surface of the hoof. The outer surrounding border forms a projecting edge downwards; and along its inner circle are eight nails, ranged in fours, laterally, and rather near to one another. The shoe also has a curvature both at toe and heel.—The Barbary shoe differs but little, and very unimportantly, from the Asian productions. The striking character of it is, that the hole in the middle, instead of being circular, is triangular.—The bar-shoe seems to have been formed on the type of the Asian shoes, but is used in Britain only in cases of disease. See the article Bar-Shoe.

The comparative weight and size of shoes are of fully as much importance as their form, and ought to be as nicely adapted as possible to the strength, bulk, character, and work of the horse. A weak foot should never wear a heavy shoe; a small foot should never wear a large one; a horse on light work or constantly on soft ground should never wear as heavy a one as the same horse on severe work or constantly on hard ground; a horse with peculiarly shaped feet should never wear one of the ordinary or normal shape, unadapted to the specialities in the foot's configuration; and a horse of comparatively rapid motion and slight performance should never wear as heavy a one as a horse of comparatively slow motion and laboured performance. According to the estimate of Professor Coleman, the shoe of a large draught horse, on the average, should weigh 2 lb. 10 oz., that of a small draught horse 1 lb. 10 oz., that of a large coach horse 1 lb. 10 oz., that of a small coach horse 1 lb. 4 oz., that of a saddle horse 1 lb. 4 oz., and that of a racing horse 5 oz.

The mode of putting on the shoe, and particularly the proper paring of the hoof for its reception, are also of as much importance as its form. "Many," says White, "have attended chiefly to the form of the shoe, and not to its application, or to the hoof; and this error has done more mischief, and made more enemies to the Veterinary College, than all the prejudices and calumnies of grooms and farriers. The first thing to be attended to is to take away, with the butteris, a portion of the sole between the whole length of the bars and crust with a drawing knife; for the heels of the sole cannot receive pressure without corns. To avoid this, the soles should be made concave, so as not to be in contact with the shoe. If there be any one part of shoeing more important than the rest, it is this removal of the horn be-

tween the bars and crust. When this is done, the horse will always be free from corns, whatever be the form of the shoe. Beside this, the heels of the shoe should be made to rest on the junction of the bar with the crust. If a shoe does not leave ample space for a picker to be passed under it, either the shoe or the sole should be made more concave. When the sole appears in flakes and thick in substance, it will be better to make the sole sufficiently hollow to admit of the application of a flat shoe, as it will rest only in that case on the crust. But when the sole will not allow of being thus pared, the shoe must then be made sufficiently concave on the surface next the foot, that the picker may be passed easily under it. But even in flat or convex feet, the horn is generally sufficiently strong towards the heels to allow of being pared moderately and made concave. In shoeing the hind foot, it will be sufficient to pare off the horn from the sole, and make an even surface for the shoe, which may always be flat on both surfaces; as no inconvenience would arise if it happen to bear a little on the sole. It is usual to turn up one or both heels of the hind shoe to prevent slipping. This should not be done unless the horse is worked in situations which render it necessary; and then the outer heel only should be turned up, and the inner heel made thicker than the toe and quarter, so that both heels may be equal."—See the articles Foot, Paring the Hoof, Navicular Bone, Grogginess, and Founder.

SHOODS. Oat hulls.

SHOREWEED,—botanically *Littorella Lacustris*. A beautiful, perennial, herbaceous, subaquatic, indigenous plant, of the plantain family. It inhabits wet sandy places on the shores. Its root is tap-shaped and fleshy, and throws up many long, linear, channelled leaves; and its flowers have a whitish-green colour, and bloom from June till August. Some flowers on any one plant are barren, and others fertile; and the barren ones have long tremulous stamens.

SHORT-HORNS. See Cattle.

SHOT-OF-BLOOD. See Inflammatory Fever.

SHOULDER. The shoulder of the horse demands the special study of both the breeder and the veterinarian. The muscles of it must be bulky enough to confer a considerable degree of power, and to maintain a sufficient continuance of exertion; but they should not be so bulky or mis-shapen as to give the shoulder a loaded appearance; and those of all saddle-horses should increase from the neck backward with such imperceptible gradation as to make neck and shoulder seem to be of one piece. The two bones, the scapula and the humerus, should stand, not on a straight line to each other, but obliquely,—the scapula inclining so far backward that the lower end shall meet the humerus in a slanting direction; for when they are thus adjusted, they obviate concussion and greatly facilitate all the actions of the limb, and conduce to rapidity of motion, and render the paces of the animal eminently smooth and safe. A horse with an upright shoulder has always a comparatively large supply of humeral muscle, and is thick and cloddy about the upper part of the neck, and must, in consequence, be proportionally heavy, ill-going, and unsymmetrical in all the actions of the fore-part of his body.

A lameness or sprain in the shoulder of the horse is not infrequent. The most common cause of it is a mis-step or some twist or outstretch in action. It is situated too deep to show itself by any external signs upon its immediate seat, or to be discoverable by means of anything which can be seen or felt there; and is indicated principally by the peculiar gait of the animal, or by the dragging of his toe and the circuitous fling he gives the limb in action, corroborated by the absence of any other visible or assignable cause for the lameness. If a doubt exist as to whether the evil be in the shoulder or in the leg or in the toe, an expression of great pain on the horse's part when the foot of the affected limb is lifted and then brought considerably forward will decidedly indicate the lameness to be in the shoulder. The proper remedies are the drawing of blood from the vein on the inside of the arm, the giving of a dose of physic, the application of fomentations on the inside of the arm close to the chest, the keeping of the animal quiet and comfortable, and, if all these remedies prove insufficient, in the course of eight or ten days, the blistering of the whole surface around the point of the shoulder by means of an infusion of cantharides applied without removing the hair.

SHOVEL. A hand-implement of the spade kind, used for collecting and lifting. It differs from a true spade in having a broader and thinner blade, and in not being used for cutting and digging. Several varieties of it are used on the farm, for widely different purposes, and differing from one another in the size, form, and material of the blade. The barn shovel is the most remarkable, and generally has the blade of wood, sometimes edged with iron.

SHOVELER, — scientifically *Anas Clypeata*. A winged winter visiter of Britain, belonging to the swan group of palmipede birds. It is called also the broad-bill and the blue-winged shoveler. Its total length is about 20 inches. The head and the upper part of the neck of the adult male is green; the lower part of the neck is white; and the other parts of the body display mixtures and shadings of white, pale blue, dark brown, and other colours. The shoveler frequents lakes, rivers, marshes, and muddy shores; and feeds on grasses, herbs, worms, insects, and small aquatic animals; and selects its food in shallow water.

SHOWEL. A blind for a cow's eyes.

SHREW, — zoologically *Sorex*. A genus of small carnivorous mammals, somewhat allied to

the moles. They live in holes which they dig in the earth, and seldom leave them till the evening; and they feed on insects and worms. They are covered with hair, and have on each flank a small band of stiff, thickly-set setæ, and discharge from that part of their body, during the rutting season, an odorous humour. The shrew mouse or common shrew, *Sorex araneus*, is grey above and ash-coloured below, and has white teeth, exposed ears, and square tail. It occurs in fields, meadows, and similar situations. It has been accused, but falsely, of producing a disease in horses by its bite. Cats kill it, but will not eat it.—The water-shrew, *Sorex fodiens*, is rather larger than the common one; and is black above and white below; and has red-tipped incisors, partially hidden ears, and a terminally compressed tail. It frequents the banks of brooks, and has amphibious habits. It is very rare in Britain, and was at one time supposed, though incorrectly, to have been exterminated.

SHRIKE,—zoologically *Lanius*. A genus of birds of the dentirostrous tribe of passerinæ. Their bill is triangular at the base, and compressed on the sides. They live in families, and build neatly on trees, and imitate part of the song of musical birds in their vicinity, and fly irregularly and precipitately, uttering shrill cries.

The great grey shrike, or great butcher-bird, *Lanius excubitor*, is as large as a thrush, ash-coloured above, white below, and black in the wings and tail, and has a black band round the eye, and some white on the scapulars, on the base of the wing-quills, and on the external edge of the lateral tail-quills. It remains in France throughout the year, but is only an occasional visiter in England, chiefly between autumn and spring. It feeds on mice, shrews, frogs, lizards, small birds, and insects; and first kills its prey, and then transfixes it on a thorn or on some similar object, and then tears it thence piecemeal.

The flayer or small butcher-bird or red-backed shrike, *Lanius colluris*, has a total length of about 7½ inches. It is ash-coloured on the head and the rump, fawn-coloured on the back and the wings, whitish below, black on the wing-quills with an edging of fawn-colour, and black in the tail-quills, but white on the base of the lateral ones, and it has a black band over the eye. This species has similar habits of treating its prey to the preceding, and hence shares with it the popular name of butcher-bird.

The woodchat shrike, *Lanius rufus*, resembles the flayer in size, in mode of feeding, and in most of its habits; but it differs in plumage, and is of rarer occurrence. Its forehead, its back, its wings, its wing-coverts, and the space round its eyes are black; the top of its head and of its neck is livid red; and its throat, its breast, its belly, and other parts are white.

SHRUB. A low, bushy, ligneous plant, differing from a tree, not only in lowness of stature, but in denseness of habit and in feathering down to the ground,—either sending up several stems from the root crown, or commencing its ramifications from one stem immediately above the surface of the ground. Good examples of hardy, common shrubs are furze, juniper, and holly.

SHRUBBERY. An ornamental collection of shrubs and dwarf trees, or a pleasure-ground, of the size and nature of a garden, decorated principally with these plants. The construction of a shrubbery, both as to disposition of the ground and as to selection of the shrubs, is exceedingly various, and depends much on taste and on the nature of the locality, yet ought to be determined, on the whole, by the general principles of landscape gardening. See the article Landscape Gardening.

SHRUBBY TREFOIL, — botanically *Ptelea*. A small genus of ornamental shrubs, of the terebinth family. The three-leaved species, *Ptelea trifoliata*, is a native of Virginia and Carolina, and was introduced to Britain near the beginning of last century. It commonly attains a height of about 10 or 12 feet. Its branches are not very numerous, and are brittle, full of pith, and covered with a smooth purplish bark, and, when broken, emit a strong scent; its leaves are trifoliate, and stand on long footstalks, irregularly on the branches; its folioles are oval, spear-shaped, and pretty large when fully out, and have a pleasant, strong green colour above, and a lighter colour and smooth surface below, and are late in exfoliating and in attaining their full size; and its flowers come out in bunches at the end of the branches, and have a whitish-green colour, and bloom in June and July. This plant thrives in any common soil, and may be propagated from either seeds, cuttings, or layers.

SHUCK. A husk or shell; also, a shock or stook of twelve sheaves.

SHUGGING. The shedding of the seeds of over-ripe grain at harvest.

SHYING. A horse's starting suddenly aside, either from skittishness, from fear, or from the force of habit. One cause of it is mere constitutional or mischievous playfulness; another is oddity or frightsomeness in strange objects or new circumstances; another is the recollection, by association of place or otherwise, of cruelty or accident; and a fourth is dimness of sight or incipient blindness, induced by advanced age or by disease. Combined firmness and kindness is the proper treatment of the evil when arising from either the first, the second, or the third of these causes; and discrimination and encouragement, even more than firmness, when it arises from the last. Severity, in every case, is very injurious; and caressing, in most cases, is bad. No more, in most instances, should be done with a saddle horse in the act of shying than to employ sufficient steadiness of hand for the effecting of due restraint.

SIBBALDIA. A genus of curious, herbaceous, small, alpine plants, of the rosaceous order. The procumbent species, *S. procumbens*, grows wild and plenteously on the micaceous soils of the lofty mountains of the Scottish Highlands. Its root is perennial; its stems are spreading, cylindrical, from one inch to three inches long, and clothed with coarse upright hairs; its leaflets are wedge-shaped, from half an inch to one inch long, and of a bright green colour; and its flowers grow in corymbose leafy tufts, and have small petals and large hairy calyxes, and are of a yellow colour, and bloom from June till August. The whole plant is astringent.—Two exotic varieties have been introduced from respectively Switzerland and North America; and three hardy, perennial-rooted, erect-growing species, of from 4 to 12 inches in height, have been introduced from other countries.

SIBERIAN PEA-TREE. See CARAGANA.

SIBTHORPIA. A small genus of curious, small, herbaceous plants, of the figwort order. The European or creeping sibthorpia, or Cornish moneywort, *S. europœa*, grows wild in watery shady places, about springs and brooks, in the south of England. Its roots are perennial, woody, and fibrous; its stems are prostrate, creeping, entangled, branched, wide-spreading, slender, delicate, and minutely hairy; its leaves are stalked, alternate, rounded, light green, and rather succulent; and its flowers are axillary, solitary, minute, and white, and bloom in July and August. This plant may be artificially propagated by division, and grown in moist peaty soil.

SICKLE. A hook-shaped hand-implement for reaping corn. It is commonly called in Scotland a reaping-hook, or simply a hook or heuk. It varies, in different districts, and from different manufactories, in size, form, weight, edge, temper, and the quality of the material; but, in a general view, belongs to one of two classes,—the smooth and the serrated. A good smooth sickle weighs 1 lb., and has a cutting edge of 20 inches in length, and is mounted with a beech or plane-tree handle of about 6 inches in length and 4½ inches in circumference; and a good serrated sickle weighs about 9 oz., and has a cutting-edge of 16 inches in length, serrated to the depth of $\frac{1}{25}$ of an inch, with about 300 serratures, all pointed backward or toward the handle. See the articles SCYTHE, HAINAULT SCYTHE, and REAPING.

SICKNESS (THE). See BRAXY.

SICYOS. A genus of annual, climbing, yellow-flowered, culinary plants, of the gourd family. Five hardy species, all similar in habit and appearance to cucumbers, and naturally blooming from July till September, have been introduced to Britain from Continental America and the West Indies. They are popularly called single-seeded cucumbers. They either propagate themselves, or may be artificially propagated, from seeds; but they are too rambling and spreading for small gardens, and ought to be assigned a place near a hedge on which they may climb.

SIDA. A large genus of exotic plants, of the mallow family. About 120 species have been introduced to Britain; and at least 80 more are known. But they possess little floral or economical importance compared to their numbers; and, in the great majority of instances, attract the attention only of botanists. Some are annuals, a few biennials, some herbaceous perennials, and some evergreen shrubs. Among the prettiest of the annuals, are *S. juvenalis* and *S. Csereii*, both white-flowered; of the herbaceous perennials, *S. altaica* and *S. stylosa*, yellowish-flowered, and *S. regia* and *S. virginica*, scarlet-flowered; and of the evergreen shrubs, *S. rosea*, rosy-petaled, *S. inœqualis*, white-flowered, and *S. aurea*, golden-flowered or orange and red flowered. The poplar-leaved species, *S. populifolia*, a yellow-flowered annual of about a foot in height, introduced to Britain about 52 years ago, grows wild in India, and is much used there, by both natives and Europeans, as a medicinal plant,—a decoction of its leaves in the way of emollient fomentation, the expressed juice of them as a cooling remedy in gonorrhœa, and an infusion of the root as a drink in fevers. The root of the lance-leaved species, *S. lanceolata*, has an appearance not unlike that of common liquorice, but is intensely bitter; and it is used in India as a stomachic, as a good remedy in chronic bowel affections, and, in infusion along with ginger, in cases of intermittent fever. The chewed leaves of the hornbeam-leaved species, *S. carpinifolia*, a yellow-flowered, evergreen shrub of 3 feet in height, introduced to Britain upwards of 70 years from the Canaries, allay the inflammation occasioned by the sting of wasps. The straight shoots of the small-flowered species, *S. micrantha*, are used at Rio Janeiro as rocket-sticks. The abutilon or broad-leaved species, *S. abutilon*, is cultivated in India and China for the fibre of its stems, and has even been somewhat extensively introduced into the field culture of Italy and the south of France, and may possibly become so acclimated and productive as, at no distant day, to deserve well the attention of farmers in the south of England. It is a native of both the West Indies, of the East Indies, and of China, and was introduced to the hothouse collections of Britain toward the close of the 16th century. Its roots are annual; its stems are generally simple and from 3 to 5 feet high; its leaves are stalked, broadly cordate, pointed, dentated, and slightly downy; and its flowers are small, and have a simple angular calyx and a pale yellow corolla, and naturally bloom from June till August. This species, also, is the type of a somewhat recently constituted genus, which takes the name of abutilon, and comprises all the species of the old genus sida which have many-seeded carpels,—

leaving only those species to be still called sidas which have one-seeded carpels.

SIDERITIS. See ALL-HEAL (CLOWN'S).

SIDEROXYLON. See IRON-WOOD.

SIDESADDLE-FLOWER. See SARRACENIA.

SIEGESBECKIA. A genus of curious and ornamental, exotic, annual plants, of the sunflower division of the composite order. Six species, chiefly yellow-flowered and about 2 feet high, and all late in blooming, have been introduced to Britain from Mexico, Peru, Iberia, and India.

SIEVE. An implement for separating smaller particles from larger ones. Sieves of many kinds are used in not a few departments of the useful arts, chiefly for separating finer grains or powders from coarser ones; and sieves of several constructions and of different varieties are used on the farm for separating cereal grain and other seeds from dust and general impurities. Most sieves are textures of basket-work, wire, gut, or hair, stretched on a broad wooden hoop; but some consist of perforated and stretched skins or iron-plates; and a few, for very fine work, particularly in the pharmaceutical processes of the druggist and the practical chemist, consist of lawn or other fine cloth stretched within high, thin, circular frames. Barn sieves require to be of different capacities for respectively beans, wheat, oats, rape-seed, and other produce. An excellent complex implement, called a seed-sifter, and well adapted for the separating and cleaning of ryegrass seeds, was invented about 12 years ago by Mr. Leckie of Haddington, and is modelled in the Museum of the Highland Society, and described and figured in the 12th volume of their Transactions. It contains three wire sieves, of different width of mesh, and is worked by means of a winch-handle and connecting machinery. "The rough seed is put into the upper sieve, which, by agitation, allows the ryegrass and smaller seeds to pass through, while husks and larger seeds are retained. The former are received upon the middle sieve and subjected to a second separation in which the fine ryegrass, dust, and small seeds only are passed through. These falling upon the lower or sloping sieve, are again separated, the dust and small seeds fall through this as waste, and the ryegrass seed in a clean state is discharged over the lower edge."

SIEVERSIA. A genus of ornamental, hardy, perennial-rooted, yellow-flowered, herbaceous plants, of the rosaceous order. Six or seven species, all but a few inches in height, and blooming from about midsummer till some time in autumn, have been introduced to Britain from North America, Continental Europe, and Siberia; and they, for the most part, love a soil of peaty loam, and are propagated by division.

SIFTING. The separating of seeds from impurities, or of smaller particles from larger, by means of implements. See the articles SIEVE, SCREEN, and THRASHING-MACHINE.

SILAUS. See PEPPER SAXIFRAGE.

SILENE. See CATCHFLY.

SILEX. See SILICA.

SILICA. The oxide of silicium. It possesses great interest to the chemist, on account of its remarkable affinities and reactions,—to the geologist, on account of its vast predominance in many kinds of rock, or of its constituting a very large portion of the crust of the world,—to the mineralogist, on account of its being the chief ingredient in many gems and other rare and beautiful minerals,—to the phytologist, on account of its forming an essential part of the food of plants,—and to the agriculturist, on account of its intimate connexion with the offices of soils and manures.

Silicium or silicon is a simple body, belonging to the same group of elements as carbon and boron. It does not naturally exist in an uncombined state; and was first demonstrated to be a distinct body by Sir Humphrey Davy; and first obtained, in a pure separate state, in 1824, by Berzelius. It may be prepared in several ways,—but, most conveniently by decomposing highly dried double fluoride of silicium and potassium or sodium, and afterwards driving off some combined hydrogen and some adhering silica. It is a dark nut-brown substance, perfectly destitute of metallic lustre, a non-conductor of electricity, incombustible in air or in oxygen, infusible by the flame of the blow-pipe, and insoluble in sulphuric, nitric, muriatic, or hydrofluoric acid, but vividly combustible in contact with carbonate of potash or soda, deflagrable in mixture with nitre under a high temperature, and explosible by being dropped upon fused hydrate of potash, soda, or baryta.

Silica or silex is one of the most abundant earthy substances in the world. It forms a great proportion of the primitive rocks; it is the chief ingredient in sandstones; it constitutes by far the main part of quartz rock, and is nearly identical with flint; it forms from 50 to 70 per cent. of the total bulk of most barren soils, and from 50 to 85 per cent. of the total bulk of most fertile soils; and, under a great variety of slightly modifying circumstances, it constitutes almost the entire substance of calcedony, agate, jasper, rock crystal, and other analogous gems. It may be obtained in comparative purity by throwing red-hot pieces of transparent rock crystal into water, and afterwards pulverizing them; and, as thus obtained, it is a light, white, insipid, inodorous powder, rough and dry when rubbed between the fingers, totally insoluble in water, fixed or quite infusible in the fire, but more readily fusible than lime or magnesia before the oxyhydrogen blow-pipe. It is not acted on by any acid except the hydrofluoric; but it dissolves in solutions of the fixed alkalies, and combines with many of the metallic oxides. Silica itself, though incapable of acid reaction upon vegetable colours, claims, in reference to its behaviour with

alkaline bodies, to be called silicic acid; and the many earthy combinations of it with potash and soda and lime and magnesia and other salifiable bases in rocks and soils and gems, must be regarded as true salts or native silicates. Several of the varieties of silica itself, but especially all the most common salts of it, or most abundant native silicates, occur both naturally and artificially, under modifications or in contact with substances or in exposure to agencies, which completely subdue its refractoriness and insolubility, and render it facilely and abundantly available for absorption by plants.

"Quartz," says Liebig, "forms a very pure variety of silica, and, in this condition, it is quite insoluble both in cold and in hot water, is without taste, and does not exert any action on vegetable colours. The principal property of silica in this state is, that it unites with alkalies, forming saline compounds, which are termed silicates. Window and plate glasses consist of mixtures of silicates of the alkaline bases, potash, soda, and lime. In such compounds, the alkali is generally completely neutralised. The property of neutralising metallic oxides and alkalies belongs only to acids; and it is owing to this that silica has received the name of silicic acid. Silica is a very feeble acid, for, in its crystallised form, it is destitute both of taste and of solubility in water; but it dissolves by continued digestion in alkaline leys. We may easily obtain compounds of silica with potash and soda, by melting it either with a pure alkali, or with an alkaline carbonate. By this treatment, white glasses are obtained, differing in properties according to their amount of soluble ingredients. When the glass contains 70 per cent. of silica and 30 per cent. of potash or soda, it becomes soluble in boiling water. Its solution may be spread over a surface of wood or of iron, and then dries into a vitreous substance, which has received the name of soluble glass. When there is a smaller proportion of alkali than the above quantity, or, in other words, when there is a larger proportion of silica, the resulting glass diminishes in solubility in a greater or less degree. All silicates soluble in water are decomposed by acids. If the solution of the silicate contains silica corresponding to more than $\frac{1}{30}$ the weight of the water, the addition of an acid causes the formation of a precipitate of a very gelatinous appearance. This precipitate, being a compound of silica with water, is termed the hydrate of silica. But, if the solution contains less silica than the above proportion, no precipitate is formed on the addition of an acid, the whole remaining perfectly clear. This circumstance proves that silica, in the state in which it is precipitated by an acid, possesses a certain degree of solubility in pure water. Indeed, by washing with water the gelatinous precipitate of silica, its volume diminishes, and silica may be detected in solution by evaporating the water which has passed through. From these facts we perceive, that silica possesses two distinct chemical characters. In the form in which it is separated from a silicate, it possesses quite different properties from those which it has when in the state of sand, quartz, or rock crystal. When sufficient water is present during its separation from a base, to effect its solution, the whole remains dissolved; in certain conditions, silica is more soluble in water than gypsum. On drying, silica loses almost completely its solubility in water. The solution of silica in acids acquires, at a certain degree of concentration after cooling, such a gelatinous consistence that the vessel containing it may be turned upside down without spilling a drop of the transparent jelly. By drying it still further, the water which retained it in the gelatinous condition, escapes along with that which had served to hold it in solution. When the water has been once removed in this way, the silica is no longer soluble in water. But, although it has thus lost its solubility, it does not acquire all the properties of crystallised silica, such as sand and quartz, for it still possesses the power of dissolving in alkalies and alkaline carbonates at the ordinary temperature of the air, and this power it retains even when it has been heated to redness. There is scarcely any other mineral substance which can be compared to silica for the possession of such remarkable properties as those now described.

"Most of the insoluble silicates containing alkaline bases are decomposed by the action of hot water, particularly when that water contains an acid. In the middle of the last century, the ignorance of this fact led chemists to believe that water might be converted into an earth. When water is distilled in glass vessels, it is found to contain always a certain quantity of earthy substances, which may be detected by evaporation, even if the water has been subjected to many repeated distillations. Lavoisier proved that part of the glass was dissolved in this operation by the boiling water; and further, that the diminution in the weight of the glass vessel corresponded exactly to the quantity of earthy residue left by the evaporation of the water. When the distillation of water is effected in metallic vessels, no such residue can be obtained. The action of water upon the silicates contained in glass may be observed in the opacity which gradually comes over the windows of hot-beds, these being exposed in a great degree to the influence of the air. This action is more marked in the windows of stables, where the carbonic acid formed by the processes of respiration of the animals, and by the decay of animal matter, accelerates the decomposition.

"Silica being an acid of a very feeble character, the decomposition of the soluble silicates is effected even by carbonic acid. A solution of soluble glass may be converted into a gelatinous

mass by saturating it with carbonic acid gas. The same decomposition must take place in very dilute solutions, although we cannot detect in them any separation of silica, which remains dissolved in the water. The decomposition of silicates by the combined action of water and of acids proceeds with a rapidity proportional to the quantity of alkalies contained in them. We find numerous examples in the inorganic kingdom of a continued and progressing process of decomposition of the silicates contained in the various kinds of rocks; this decomposition is effected by the action of carbonic acid and of water.

"A consideration of the preceding observations shows clearly that porcelain clay or kaolin has been formed by the decomposing action of water on the silicates of potash and soda contained in felspar or felspathic rocks. Felspar may be viewed as a combination of silicate of alumina with silicate of potash; the last of which, being gradually removed by water, leaves behind the porcelain clay. It has been shown by Forchammer, that felspar may be decomposed by water of 302° F., and at a pressure corresponding to this temperature. The water becomes strongly alkaline, and is found to contain silica in solution. The hot springs in Iceland possess a high temperature, and come from a great depth, where they must have been subjected to high pressure. Forchammer has shown by analysis that the water of these springs contains the constituents of soda felspars, and of magnesian silicates, minerals of very frequent occurrence in trap districts. There cannot be a doubt that a conversion of crystalline felspar into clay must be proceeding to a great extent at the bottom of these springs. Ordinary water containing carbonic acid acts in precisely the same manner as water at a high temperature, and at a high pressure. Polstorf and Wiegmann boiled some white sand with a mixture of nitric and muriatic acids, and after completely removing the acid by washing the sand with water, they exposed it thus purified to the action of water saturated with carbonic acid gas. After the expiration of 30 days, this water was subjected to analysis, and was found to contain in solution, silica, carbonate of potash, and also lime and magnesia; thus proving that the silicates contained in the sand were unable to withstand the continued action of water containing carbonic acid, although the same silicates had resisted the short action of the aqua regia.

"Certain of the alkaline silicates found in nature contain in their crystalline state water in chemical combination. In this class are the zeolites, analcime, mesotype, sodalite, apophyllite, &c.; the felspars, properly so called, are always anhydrous. These silicates differ very much in their behaviour to acid reagents. When mesotype, or a mineral corresponding to it in composition, is kept in the state of a fine powder in contact with cold muriatic acid, it increases in bulk to a thick jelly. The mineral being exposed to the action of the acid at the ordinary temperature, those constituents which are soluble in the acid are taken up by it whilst the greatest part of the silica remains undissolved. Labrador spar (calcareous felspar) behaves similarly when treated with acids; but the minerals adularia and albite (potash and soda felspars) are not attacked by acids under similar circumstances."

Silica, under soluble conditions, is a comparatively large ingredient in the food of agricultural plants, and plays an important part in the fertility of soils. The quantity of it in any one species of plant varies in different parts of the plant, in different varieties of the species, and upon different kinds of soil. The quantity of it, in the mean of six specimens of turnip bulbs, analysed by Professor Wey and Mr. Ogston, amounted to 0·34 lb. per ton; in the mean of six specimens of turnip-tops, to 1·73 lb. per ton; in the mean of six specimens of entire crops of turnips, to 0·55 lb. per ton; in the mean of three specimens of beet-bulbs, to 0·54 lb. per ton; in the mean of three specimens of beet-leaf, to 0·76 lb. per ton; in the mean of three specimens of entire crops of beet, to 0·56 lb. per ton; in the mean of five specimens of carrot-roots, to 0·24 lb. per ton; in the mean of three specimens of carrot leaves, to 4·46 lbs. per ton; in the mean of three specimens of entire crops of carrots, to 1·22 lb. per ton. The quantity of silica, according to the same authority, amounts to 0·61 lb. per ton in the tubers of Jerusalem artichoke, to 1·76 lb. per ton in pease grown on chalk, to 0·84 lb. per ton in pease grown on clay, to 2·53 lbs. per ton in pease straw grown on chalk, to 5·04 lbs. per ton in the entire crop of pease grown on clay, to 1·94 lb. per ton in pease straw grown on clay, to 0·42 lb. per ton in beans grown on clay, to 2·61 lbs. per ton in bean straw grown on clay, to 3·17 lbs. per ton in the entire crop of beans grown on clay, to 60·0 lbs. per ton in wheat straw, to 172·1875 lbs. per ton in wheat chaff, and to 16⅜ oz. in every 28 bushels or 1,792 lbs. of wheat grain. Two important practical inferences from these facts, are, that the root crops bring up soluble silica from the deep parts of the soil, or assist the subjugation of crystalline silica under soluble condition in the higher parts of the soil, in preparation for the uses of the corn crops,—and that by far the major portion of all the soluble silica abstracted from the soil by a whole course of crops, may be returned to it in the leaves or tops of the root crops and especially in the straw and chaff of the grain crops. A main office which silica appears to perform is to give mechanical firmness and strength and resistiveness to the parts and organs of plants which are most exposed to the risk of fracture or postration or other injury from the weather; and therefore it is scarcest in the pulp or farina of seeds and in

the flesh of succulent roots, less scarce in leaves, more abundant in culms, and most plentiful in the sheltering chaff-coats of the ripening grain.

The quantity of soluble silica in most soils, or of silica under conditions which render it capable of solution and readily available for the use of plants, is so great as to render special applications of it altogether unnecessary. The small proportion of it, too, which is carried off by the seeds of field crops, and not returned in the portions of farm-yard manure which consist of leaves and culms and chaff, is, in general, far more than compensated by the disintegration of part of the insoluble silicious constituents of the soil in the operations of fallowing and tillage, and by the bringing up of soluble silica from the lower parts of the soil in the absorptive process of root crops, and allowing it to remain on the field by carrying away only their bulbs or tubers or taps. "Between corn crops," as Liebig suggests, "we may grow mangel-wurzel or even potatoes, if we remove only the tubers of the latter, and allow the plant itself, which contains much silica, to remain on the field." But, in fact, most fields contain such a large natural store of available silica, that no care respecting it needs to be entertained, and no expedient for any special supply of it needs to be adopted, for centuries to come. Almost the only soils, or at least the chief ones, which may now and statedly require direct applications of it, are peat lands and other predominantly humous grounds, which contain a comparatively small proportion of mineral matter, and which produce such soft and flexuous corn-culms as want sufficient strength and firmness to resist the buffetings of the weather. Yet many scientific farmers, and even some distinguished agricultural chemists, contend that artificial silicates should be applied to all soils,—that they form an indispensable ingredient in any compound special manure which is intended to serve as a substitute for farm-yard manure,—and that they form a fit and sometimes necessary preparation for a wheat crop on any land which has suffered an appreciable abstraction of its soluble silica by the crops of the immediately preceding years. The question thus brought into dispute is one of very considerable practical importance, and requires much knowledge and very comprehensive thought for its proper investigation. Let us hear the reporter of the Agricultural Chemistry Association of Scotland upon it:—

"It may be said by some that guano and bones are both alike deficient in silica, which exists so largely in our grasses and in the stems of our corn plants; and, therefore, that some soluble silicate might with advantage be added to either of these manures, when crops of corn are to be improved by them. There is much show of reason in this when considered theoretically, and there are, no doubt, cases in which an admixture of one-fifth of its weight of silicate of soda would improve a guano, or in which the use of sulphated bones for the turnip crop might be beneficially followed by a top-dressing of silicate of soda upon the young corn of the following year. But the propriety of incurring the expense of such an application along with bones in all cases is very doubtful. Here also much will depend upon the actual constitution of the soil; for it would be a waste to add anything which the soil already contains abundantly, and in a state in which it can readily minister to the wants of the plant. Now, if a portion of soil be burned, in order to destroy the organic matter it contains, and be then boiled in distilled water for a length of time, and the filtered solution be afterwards evaporated to dryness, and the residue heated to redness to burn off the organic matter, a minute but variable quantity of saline matter will remain, in which a trace of silica will usually be found. Most soils, therefore, contain some silica in a state in which it may be taken up by water. Again, if, after boiling with water, the soil be digested for two or three hours with concentrated muriatic acid till it is perfectly colourless, and if the filtered solution be treated with ammonia and oxalate of ammonia, to separate the oxide of iron, alumina, and lime, and be then evaporated to dryness, an appreciable quantity of silica will be found in the saline matter which remains. Or, if the acid solution be at once evaporated to dryness, and then treated with water, some silica will remain insoluble. Soils, therefore, generally contain a further appreciable quantity of silica, in a state in which it is soluble in acid solutions." He then states that, of five specimens of different soils which he analyzed, one contained 0·19 per cent. of silica soluble in acid solutions, another 0·16 per cent., a third 0·2 per cent., a fourth 0·17 per cent., and the fifth at top 0·84 per cent., and at bottom 0·42 per cent.; and he adds:—"I could have given many other such results; but these show both the presence of silica in this state in our cultivated soils, and how much it varies in different soils. The quantity present in the first and third instances—1-5th of a per cent., or one pound in 500 lbs. of soil—appears very small when compared with the whole soil, and yet it proves to be large when we come to calculate how much an acre of soil will contain, and how much a crop of corn will carry off from that acre. A square yard of soil 12 inches deep, will weigh about 700 lbs., so that this extent of soil will contain 1⅔ lb. of silica soluble in acids, which amounts to 6,700 lbs. in an acre! The straw of our grain crops leaves, on an average, less than five per cent. of ash, of which less than one-half usually consists of silica, and a crop of straw rarely exceeds 3,000 lbs. per imperial acre. If we take these numbers as tolerable approximations, the quantity of silica carried off by a crop of straw amounts to 75 lbs. per acre, while the silica soluble in acids, and which it is be-

lieved plants can take up, amounts, as above, to 6,700 lbs. Or this silica will alone supply the wants of 900 crops of corn. The soil in the fifth instance contains four times as much, or it would provide silica for 3,600 crops!—Further, if the insoluble portion of the soil be washed with water, to free it from siliceous sand, and the finer or clayey part be collected and fused with carbonate of soda, and then treated with muriatic acid, a large portion of silica, in light white flocks, will remain behind; while the solution will contain alumina, lime, magnesia, and perhaps potash and soda, with which the silica had been combined in the soil. This portion of the silica of the soil is very large, and sometimes forms nearly one-half of its whole weight. In the form of silicates insoluble in muriatic acid, therefore, the soil contains an enormous quantity of silica. There can be no doubt that the roots of our corn crops are capable of taking up and appropriating that portion of the silica of the soil which is soluble in water, but it may be doubted by some if that which is taken up by acids, and especially if that which acids leave undissolved, is capable of supplying the wants of our growing crops. I will not offer here any of those theoretical considerations which induce chemists and physiologists to believe that both the silicates which are soluble and those which are insoluble in acids, are really a source of mineral nourishment to the plant. An appeal to experiment will be much more satisfactory to the practical man. Wiegman and Polstorf took fine white quartz sand, burned it to destroy any organic matter it might contain, digested it for 16 hours in strong nitro-muriatic acid, and then washed it with distilled water. Everything soluble being thus removed, seeds of different kinds, barley, oats, buckwheat, vetch, clover, and tobacco were sown in it, and watered with distilled water. They all grew and came to a greater or less height. The ash left by separate portions of the seeds and plants, when full grown, was determined and analysed. In the following table I have put together their comparative results, in so far as the silica is concerned, as well as the height to which the plants had arrived when they were gathered:—

	HEIGHT.	SILICA IN THE ASH		SILICA had increased.
		Of the Seed.	Of the Plant.	
	Inches.			Times.
Barley, . .	15	0.034	0.355	10
Oats, . . .	18	0.064	0.354	5½
Buckwheat,	18	0.004	0 075	18
Vetch, . .	10	0.013	0.135	10
Clover, . .	3½	0.009	0.091	10
Tobacco, .	5	0.001	0.549	500

Thus it appears that, from quartz sand, after it has been digested in strong acids, plants are able to extract silica as well as other kinds of inorganic nourishment, to which, in the above table, I have not alluded. The sand in which the plants had grown, was found, upon analysis, to contain 97·9 per cent. of pure silica, the remainder consisting of potash, lime, magnesia, alumina, and oxide of iron. From this experiment, therefore, we are justified in concluding that plants are capable of decomposing and extracting silica even from those silicates in the soil which are not attacked by acids. How much more easily may they decompose and appropriate the constituents of those silicates which are capable of being decomposed and dissolved by acids! Nor is it in virtue of any mysterious power that this decomposition is effected. The prolonged action of water containing carbonic acid, slowly decomposes even the most refractory silicates. The water in the soil is more or less charged with this carbonic acid—the decaying vegetable matter of the soil produces it, and the roots of living plants give it off—so that a simple chemical action is sufficient to explain how the plant can obtain food from such unpromising materials. It is an important conclusion, therefore, for practical agriculture, that the silica, which is so necessary to the growth of our corn and hay crops, abounds so much in nearly all our soils, and in a state in which the roots of plants can more or less readily take up. It satisfies us in regard to three points,—as to where and how the plants obtain their silica,—that, in general, it cannot be necessary to add silica in any form as a manure to the soil,—and, therefore, that the broad assertions of those who say that guano or bones should always be mixed with silicate of potash or soda, and who ascribe certain alleged failures of these manures to the absence of such silicates—that these assertions are hastily made and are not to be depended upon. I believe there are very few soils indeed, which, if properly treated otherwise, will refuse to yield good crops merely because a soluble silicate has not been added to them.

"There is only one legitimate purpose for which a silicate should be added to the soil—it is to supply silica to the plant. We ought not to add silicates for the purpose of supplying alkaline or earthy matter, unless some question of economy interferes. We use wood-ashes which contain silicates, because it is cheaper to add potash in this than in any other form. There is only one evidence, therefore, that the addition of a silicate has done good to our corn crop—it must have given more silica, and consequently, as it is believed, more strength to the straw. That the crop has been generally improved, that it is more luxuriant and thriving, or even that it yields a larger return of corn, will not be a proof of the virtue of the silicate. The effect may result from the action of the potash or the soda it contains, and the use of these alone might have produced the same effect. Oats grown upon a mossy soil are soft and dull in the straw, and I have found such straw to be deficient in silica. Wheat growing rankly upon a moist soil, and in a moist season, or a heavy thickly grow-

ing crop of barley, are apt to be laid by the wind, or to fall down under the weight of the ear. The straw is too feeble in all these cases, and it has been said that the use of silicates would abate the evil. Lampadius found the growth of wheat and rye to be greatly promoted by the use of a soluble silicate of potash, but the alkali might be the cause of the effect observed, and no other experiments of an accurate kind have yet been made. It is still an open question, then, whether or not we have it in our power, at our pleasure, to strengthen the straw of our corn plants—whether it would be useful to apply the soluble silicates to all soils—whether there are any to which they may be applied with advantage and profit as an ordinary manure."

SILICATES. See Silica.

SILK. According to the ancients, silk was first brought from Serica or Serinda (China), whence the silk-worm was introduced into other countries, but not until the reign of Justinian, when two Persian monks succeeded in secretly conveying a number of the eggs to Constantinople in a hollow cane (552). From these eggs Europe and America have been supplied with their race of worms. The time of the origin of the silk manufacture is uncertain, but the Chinese ascribe the invention to the empress Si-ling-shi, wife of Hoang-ti, about 2,700 years before the Christian era. However this may be, the raw material had been exported from China long before the insect which produced it, and had given employment to extensive manufactories in Persia, Tyre, &c. The invention of the celebrated Coan stuff is attributed by the Greeks to Pamphila, who is said to have taught her countrywomen of Cos to unweave the heavy silks of the East, and recompose the material into a transparent gauze, thus gaining in measure what was lost in substance. Even manufactured silk was little known in Europe before the reign of Augustus; and it is mentioned as a wanton extravagance of the prodigal Heliogabalus that he had a garment made wholly of silk. For six hundred years the culture of the silk-worm in Europe was confined to the Greek empire; but in the twelfth century, Roger, king of Sicily, introduced it into that island, whence it gradually spread to Italy, Spain, France, and other European countries.

After the worm has enveloped itself in the coccoon, seven or eight days are permitted to elapse before the balls are gathered; the next process is to destroy the life of the chrysalides, which is done either by exposure to the sun or by the heat of an oven or of steam. The coccoons are next separated from the floss, or loose, downy substance, which envelopes the compact balls, and are then ready to be reeled. For this purpose, they are thrown into a boiler of hot water, for the purpose of dissolving the gum, and, being gently pressed with a brush, to which the threads adhere, the reeler is thus enabled to disengage them. The ends of four or more of the threads thus cleared are passed through holes in an iron bar, after which two of these compound threads are twisted together, and made fast to the reel. The length of reeled silk obtained from a single coccoon varies from 300 to 600 yards; and it has been estimated that twelve pounds of coccoons, the produce of the labours of 2,800 worms, who have consumed 152 pounds of mulberry leaves, give one pound of reeled silk, which may be converted into sixteen yards of gros de Naples. Those coccoons which have been perforated cannot be reeled, but must be spun, on account of the breaks in the thread. The produce of these balls, when worked, is called *fleuret*. The raw silk, before it can be used in weaving, must be twisted or thrown, and may be converted into singles, tram, or organzine. The first is produced merely by twisting the raw silk, to give more firmness to its texture. Tram is formed by twisting together, but not very closely, two or more threads of raw silk, and usually constitutes the weft or shoot of manufactured goods. Organzine is principally used in the warp, and is formed by twisting first each individual thread, and then two or more of the threads thus twisted, with the throwing mill. The silk, when thrown, is called *hard silk*, and must be boiled in order to discharge the gum, which otherwise renders it harsh to the touch, and unfit to receive the dye. After boiling about four hours in soaped water, it is washed in clear water to discharge the soap, and is seen to have acquired that glossiness and softness of texture which forms its principal characteristic. The yarn is now ready for weaving.

Velvet (Italian, *velluto*, shaggy) is one of the richest of silken fabrics, and has been made in Europe for several centuries. In addition to the warp and shoot, of which the substance of plain goods is formed, it has a soft shag or pile, produced by the insertion of short pieces of silk under-thread doubled under the shoot, and which stand upright on its upper surface, so crowded together as entirely to conceal the interlacings of the warp and shoot. It is this pile which gives it its characteristic appearance, and softness to the touch. The beauty of velvet results, in a great degree, from the uniform evenness of its pile; and this depends on the perfect equality of the threads of which it is composed. The pile is inserted during the operation of weaving the warp and shoot. Gauze is a very light, transparent fabric of silk, said to have derived its name from having been originally brought from Gaza, a city of Palestine. Besides brocade and damask there are numerous descriptions of silk goods, popularly known by distinctive names, though varying only in the thickness of the fabric or the quality of the material, and not at all differing in the arrangements of its interlacings. Thus the plainest mode of silk weaving takes the

names of Persian, sarsnet, gros de Naples, ducapes, &c., of which the two first are of flimsy texture, and the two last are made of stouter and harder thrown organzine. Satin is a twill of a peculiar description, the soft and lustrous face of which is given by keeping a large proportion of the threads of the warp visible. When first taken out of the loom, satins are somewhat flossy or rough; and they are dressed by being rolled on heated cylinders, which operation gives them their brilliant lustre. Crape is a light and transparent article of plain weaving; Levantine, a stout, close-made, and twilled silk. Gros des Indes is formed by using different shuttles, with threads of various substances for the shoot. The process of watering silk, which gives its surface a peculiar wavy appearance, is performed by passing two pieces of silk, placed lengthwise, one on the other, between two metallic rollers; the different parts are thus subjected to different degrees of pressure, from which the wavy appearance results. Silk is embossed by passing the plain stuff between rollers, the surfaces of which contain the desired pattern, on one cylinder raised, and on the other sunk, so that the eminences of the one coincide with the depressions in the other. Silk also enters into the composition of several mixed fabrics, the most common of which is bombasin, a twilled manufacture, having its warp of silk and its shoot of worsted. Poplins and lustres are plain woven goods, with a larger proportion of silk than bombasins.

The annual value of the silk manufactures in England is stated at £14,000,000. The raw silk is imported to the amount of above 4,000,000 pounds annually, of which 1,500,000 pounds are from Bengal. In 1824, the high duty on raw silk imported was abandoned for one merely nominal; that on thrown silk was reduced nearly one half, and the admission of foreign manufactured goods was rendered legal, after July 5, 1826. In the five years preceding this change, the importation of raw and thrown silk had amounted to 10,925,646 pounds; in the five years succeeding, the total amount of the importation was 18,582,213 pounds. The admission of foreign manufactured silks has also led to a great improvement in the quality of the domestic manufactures. The value of manufactured silks exported from France in 1824, was 100,000,000 francs. Italy supplies England and France with a large quantity of raw silk. Some attention has recently been paid in the United States to the rearing of the silk-worm; great numbers of mulberry trees have been planted in different parts of the Union, and attempts have been made to introduce the manufacture of silks in the country. Several experiments have been made also as to the producing of silk in England; but hitherto they have been very discouraging.

SILK COTTON TREE. See Bombax.

SILK-TREE. The Acacia Julibrissin. See the article Acacia.

SILKWORM (*Bombyx mori*). This seemingly insignificant insect has now become one of the most important to man of all domestic animals. It was originally a native of China, and the neighbouring parts of Asia, and was there bred and domesticated for a long time before it was known in Europe. Now, the manufacture of silk is one of the most important sources of wealth to many parts of that continent. At first, silk stuffs were sold for their weight in gold; but they are now comparatively cheap. The silk-worm is a caterpillar, which, in due time, undergoes its metamorphoses, and becomes a moth, like others of the genus. At birth, and for the first ten days, the colour of the worm is blackish or obscure. As it grows, it casts its skin at stated periods, and turns whitish or bluish, and, when ready to spin, becomes yellow. It is covered with scattering hairs, and has a little fleshy tubercle on the upper part of the last ring. It feeds on the mulberry. Before spinning, it fasts for thirty-six hours, voids all its excrements, becomes soft and flaccid, and seeks a suitable place for the construction of its coccoon. Two or three days are occupied in this work, and the thread is stated by Count Dandolo to be sometimes 625 yards in length. The worm then changes to a chrysalis, and, after remaining twenty days, the moth comes out, forcing its way through the coccoon. The males first appear, and are very brisk in their motions, but do not fly, at least in cold climates. They live but a few days, and the females perish also as soon as they have deposited their eggs. The eggs are attached, often to the number of five hundred, or more, by means of a gummy substance, and hatch in the ensuing spring. The successful rearing of silk-worms is a distinct art, and requires peculiar attention. They are subject to a variety of maladies. In many places, it is usual to import the eggs from some district that has acquired reputation for their production. These are packed like grain, and are chosen much in the same manner. The eggs are in many places hatched by the heat of the human body. The silk is contained, in the form of a fluid, resembling varnish, in long cylindrical sacks, many times the length of the animal, and capable of being unfolded by immersion in water. This fluid is easily forced out, and advantage is sometimes taken of this circumstance to procure threads much coarser than usual, which are extremely strong, and impermeable to water.

SILPHIUM. A genus of hardy, perennial-rooted, yellow-flowered, herbaceous, North-American plants, of the sunflower division of the composite order. About 15 species, varying in height from 2½ to 14 feet, and blooming from about the end of summer till near the beginning of winter, have been introduced to Britain. They are sometimes popularly called bastard chrysanthe-

mums; but though two or three are somewhat ornamental, the majority have the look of mere weeds. They thrive in any common soil, and are propagated by division.

SILVER. A metal which appears to have been known almost as early as gold, and, without doubt, for the same reason, because it occurs very frequently in a state of purity in the earth, and requires but an ordinary heat for its fusion. Mention is made of silver in the book of Job, which is considered the oldest of the books contained in the Old Testament. Pure silver is of a fine white colour, with a shade of yellow, without either taste or smell, and, in brilliancy, is inferior to none of the metallic bodies, if we except polished steel. It is softer than copper, but harder than gold. When melted, its specific gravity is 10·47; when hammered, 10·510. It is next in malleability to gold, having been beaten out into leaves only $\frac{1}{100000}$th of an inch in thickness. Its ductility is no less remarkable. It may be drawn out into a wire much finer than a human hair; so fine, indeed, that a single grain of silver may be extended about 400 feet in length. Its tenacity is such, that a wire of silver 0·078 of an inch in diameter is capable of supporting a weight of 187·13 pounds avoirdupois without breaking. Silver melts when heated completely red-hot; and, while in the melted state, its brilliancy is greatly augmented. If the heat be increased after the silver is melted, the liquid metal boils, and may be volatilized; but a very strong and long-continued heat is necessary. Gasto Claveas kept an ounce of silver melted in a glass-house furnace for two months, and found, by weighing it, that it had sustained a loss of one-twelfth of its weight. When heated upon charcoal under the flame of the compound blow-pipe, however, the silver is volatilized with rapidity, passing off in a visible smoke. When cooled slowly, its surface exhibits the appearance of crystals; and, if the liquid part of the metal be poured out as soon as the surface congeals, pretty large crystals of silver may be obtained. Silver is not oxidized by exposure to the air; it gradually, indeed, loses its lustre, and becomes tarnished; but this is owing to a different cause. Neither is it altered by being kept under water. But, if it be kept for a long time melted in an open vessel, it gradually attracts oxygen from the atmosphere, and is converted into an oxide.

SILVER FIR,—botanically *Picea*. A genus of trees of the pine division of the coniferous order. It was included first in the old genus pinus, and next in the later genus abies; and it possesses a somewhat close affinity to the present genus abies, or spruce fir, by its leaves being flattened and more or less pectinated and all turned toward one side, and by its seeds being irregularly shaped and more than half surrounded by the winged persistent pericarp.

The common or pectinate silver fir, *Picea pectinata*—formerly called *Pinus picea* and *Abies picea*—is a native of the mountains of northern Asia and northern Continental Europe, and was introduced from Germany to Britain about the beginning of the 17th century. Its stem is tall; its form is pyramidal; its branches grow horizontally and in regular whorls; its bark is light-coloured and smooth; its leaves are pectinate, smooth, flattened, dark green, rather upwards of an inch in length, and rounded or very slightly indented at the point, and have one deep central channel on their upper side, and two silvery channels on their under side; its male catkins are stalked and shortly cylindrical; its cones are erect, cylindrical, from 4 to 6 inches long, fully one inch in diameter, and of a purplish colour in most varieties but white in some; its scales are rounded, very broad, incurved on the external edge, and toothed on the sides; and its seeds are triangular, somewhat wrinkled, fully one-third of an inch long, and nearly surrounded with a persistent, shining, brownish-purple pericarp, and contain each 4 or 5 cotyledons. This tree naturally inhabits altitudes immediately below the zone of the wild pine or *Pinus sylvestris;* and is exceedingly hardy as a plantation forest-tree in Britain; and will more or less grow in most situations and soils; yet it is very impatient of the sea-breeze, and makes most progress on good, rich, loamy, deep, rather moist land, in glens or at the base of hills or mountains, and does not thrive well or live long on soil which is either poor or shallow, or in a situation which is bleak or lofty. On its native grounds in Germany, it has always a perfectly straight stem, and attains a height of from 50 to 120 feet, and measures from 10 to 20 feet in girth at two yards from the ground, and is eventually cut from the Black Forest into valuable planks and sent in 'floating villages' down the Rhine to Holland; and in favourable situations, under proper management, in Britain, it is both a free-growing and a highly ornamental tree. A plant of it in Woburn Park, a few years ago, when about the age of 110 years, was 110 feet high, and measured 10½ feet in girth at 4 feet from the ground, and contained 375 cubic feet of timber. The common silver fir is of slower growth, in its earlier years, indeed, than some other hardy and favourite trees of its class; but, after about 15 years, it almost always takes the lead of at once the larch, the spruce, and the Scotch pine. It is, also, very subject, and fatally so, to the disease called the American blight, inflicted by a minute insect of the aphis kind; but it seems to contract this disease in consequence of stagnation and corruption of air, and may generally be protected from it by means of wide enough planting, and of free and early pruning. The reputation it has acquired of being a delicate and comparatively tender tree, appears to have arisen entirely from inattention to the conditions of situation and soil and culture which are proper or essential to its habits. Its timber

is comparatively soft and undurable; and is therefore less imported from foreign countries, and less esteemed by carpenters, than that of the Norway spruce. The liquid resin called Strasburg turpentine is obtained from artificial incisions in its bark, and from punctures of small vesicles under the bark; and is collected in large quantities, in some of the central parts of Continental Europe, by persons who have bottles slung round their waist to receive it, and who climb the trees by means of cramp-irons on their shoes to obtain it.—The twisted-branched silver fir, *Picea pectinata tortuosa*, is a curious variety of the common silver fir, with remarkably crooked or twisted branches and branchlets, of a somewhat peculiar appearance, and very suitable for either pinetums or general evergreen quarters or extensive pleasure-grounds.—The variegated-leaved silver fir, *P. p. foliis variegatis*, is a variety of a strictly ornamental kind.

The balm of Gilead fir, or American silver fir, *Picea balsamea*—formerly called *Pinus balsamea* and *Abies balsamea*—is a native of the northern provinces of North America, and was introduced to Britain toward the close of the 17th century. It is a very beautiful tree, and has an upright habit and a medium size, and has more aspiring branches and a narrower pyramidal head than the common silver fir. Its branches are horizontal; its stem-bark has in general a profusion of small elevated vesicles, which contain a clear limpid resin; its leaves are shorter, narrower, of a lighter colour, and less marked with silveriness below than those of the common silver fir, and are very closely set on the branches, and constitute in the aggregate a richly ornate foliage, and are so balmy as, when bruised, to emit a very fine terebinthine odour; its buds, for next year's shoots, swell in the autumn, and are turgid and of a fine brown colour and very ornamental during all the winter, and exude an agreeable terebinthaceous fluid of similar fragrance to that of the leaves, but stronger; its male catkins are more persistent and more numerously crowded round the shoots of the preceding season than those of the common silver fir; its cones also have a deeper purple colour, and are more swollen in the middle, and have blunter pointed bracts, and taper to both ends, and are sprinkled over at least one side with white resin; and its seeds are similar in shape to those of the common silver fir, but not more than half the size. This tree naturally occurs, not in masses, but scattered among black spruces, hemlock spruces, and other abietinous species; and inhabits principally cold, moist, comparatively poor, clay and gravel soils on the sides of mountains. But in Britain, it loves a good soil, and requires careful treatment, and, after all, often dies from dropsy or decay or other disease before it attains its twentieth or twenty-fifth year. It is much esteemed as an ornamental tree, both on account of its immediate appearance, and for sake of its pleasant fragrance. Its timber is soft, light, and inferior even to that of the common silver fir. The liquid resin popularly called Canada balsam is obtained from it by piercing its bark and puncturing its vesicles; and this was formerly supposed to be very similar to the balm of Gilead, yielded by the oriental, terebinthaceous tree, *Balsamodendron Gileadense*, and hence gave occasion to the name of balm of Gilead fir. See the articles Canada Balsam and Balsamodendron.—A variety of this species, *P. b. longifolia*, differs from the normal plant in having longer leaves and less horizontal or more upright branches.

Fraser's fir, or the double balsam silver fir, *Picea Fraseri*, is a native of Pennsylvania and Carolina, and was introduced to Britain in 1811. It has a dwarfy bushy habit, and seldom attains a height of more than about 12 feet. Its leaves are crowded, straight, flattened, rather regularly pectinated, of a somewhat lightish green colour, and silvery below; its male catkins come out at the extremity of the branches, and are compact, and somewhat oblong, and about half the length of the leaves; its cones are sessile, of a dark brownish colour, about 1½ inch long, and regularly diminishing in diameter from the middle to the two blunt ends; and its seeds are short and of a dark shining purple colour. This plant is hardy and free-growing, and serves well for shrubberies and pleasure grounds. It loves a soil of sandy loam, and may be readily propagated from seeds.

The yew-leaved silver fir, *Picea taxifolia*, is a native of North America, and was introduced to Britain in 1823. It has a pyramidal form, and attains a comparatively good size. Its branches are stiff and nearly horizontal; its bark is rather smooth; and its leaves are thickly pectinate, broad, rounded or notched at the end, of a dark colour, and about an inch or less in length. This species has some resemblance to Fraser's fir, but its bark and young buds are much darker in colour, and its leaves have sometimes a more waved form, and are generally somewhat more silvery below.

Webb's silver fir, or the remarkable silver fir, or the purple-coned Himmalayan silver fir, *Picea Webbiana*, is a native of lofty altitudes in Nepaul, and was introduced to Britain in 1822. It has a similar form and appearance to the common silver fir; but its branches are thicker,—its leaves are larger and broader, solitary and erect,—and its seeds are smaller in size and more elongated and sharp-pointed in form. "This tree," says Captain Webb, by whom it was discovered, "attains a height of 80 or 90 feet, with a diameter of the stem near the ground of 3 or 4 feet. The cone is produced on the extremity of the shoots; the leaves are about one inch long, of a beautiful light green, having a white stripe on the centre. The wood is used for planes, and even equals, in the texture of its grain and in odour, the Bermudas cedar. The fruit is said to yield at full

growth an indigo or purple pigment by expression. The silvery hue of its bark, the beautiful contrast of the leaves, with the rich purple of the cone, glittering with globules of transparent resin, produce in combination one of the most striking objects which can well be imagined, and entitle it to precedence for ornamental purposes."

The noble or large-bracted silver fir, *Picea nobilis*, is a native of the north-west coast of North America, and was introduced to Britain in 1827. It attains a comparatively great size, and promises to be a valuable timber tree for British plantations. Its bark has a somewhat purplish brown colour; its leaves grow chiefly from the sides of the branchlets, and curve upward in a sort of sickle form, and are narrow toward the base, plain on the upper side, furrowed down the middle of one side, prominently ribbed down the middle of the opposite side, acute in the point, of a lightish green colour, silvery on each side of the rib, and about an inch in length; its cones are sessile, solitary, erect, cylindrical, 6 or 7 inches long, and from 2 to 2½ inches in diameter, and grow on the upper sides of the branches; and its seeds are about as large as those of the common silver fir, but lighter in colour, and more pointed in form.

Douglas's silver fir, *Picea Douglasi*, is also a native of the north-west coast of North America, and was introduced to Britain in 1827. It is hardy enough for our climate, and generally takes on two growths in the season. It attains a considerably greater height than the common silver fir, and has a pyramidal outline. Its branches grow in regular whorls, and are at first rather aspiring, and afterwards horizontal, and slightly pendant; its bark is dark-coloured, and often has a profuse sprinkling of small, elevated, resinous vesicles, similar to those of the balm of Gilead fir; its leaves are very loosely pectinate, narrow, straight, rather acutely pointed, from ¾ of an inch to nearly 1½ inch long, and of a light or vivid green colour; its cones greatly resemble those of the cedar of Lebanon, and are 5 or 6 inches long; and its seeds are about the same size as those of the common silver fir, but more oblong, and have thin, broad, shining, pale brownish wings.

SILVER-WEED, — botanically *Argyreia*. A genus of ornamental, tropical, evergreen, twining plants, of the bindweed family. Eight or nine species, principally from 10 to 30 feet high, and carrying either white, pink, purple, or crimson flowers, have been introduced to the hothouses of Britain; and several more are known. Most formerly belonged to the genus lettsomia. Both the popular and the botanical names allude to the silvery texture of the leaves. All the species are propagated from cuttings; and most love a rich mould soil.—Silver-weed is also a popular and common name of the abundant British weed *Potentilla anserina*. See the article Potentilla.

SILYBUM. A small genus of herbaceous plants, of the thistle division of the composite order. The Virgin Mary's species, or welted thistle, or curled thistle, *Silybum marianum*, called by Linnæus *Carduus marianus*, is a biennial weed of the banks and similar situations of Britain. It has commonly a height of about 4 or 5 feet, and carries purple flowers in July. See the article Thistle.

SIMABA. A genus of tropical ligneous plants, of the simaruba family. The Orinoco species, *S. orinocensis*, was introduced to Britain about 30 years ago from Orinoco. It is an evergreen, white-flowered shrub, of about 10 feet in height; and possesses, in a comparatively high degree, some valuable medicinal properties, and is at the same time decidedly ornamental. It loves a soil of loamy peat, and may be propagated from cuttings. Another species has been introduced from Guiana; and 5 or 6 other species are known.

SIMARUBA. A small genus of tropical ligneous plants, constituting the type of the natural order Simarubeæ or Simarubaceæ. The known species of this order do not amount to twenty, and occur principally in tropical America, and are all trees or shrubs with pinnated leaves, a milky juice, and an intensely bitter bark. Several possess eminently excellent tonic properties; and all seem to be more or less medicinal. Only 5 or 6 species, belonging to the three genera simaruba, simaba, and quassia, have been introduced to British hothouses; and two of these are true simarubas, and furnish almost all the quassia-bark and quassia-wood of commerce. The flowers have a quinate calyx and a five-petalled corolla; and the fruit comprises five distant, bivalve berries, seated in a fleshy receptacle.

The officinal simaruba, *S. officinalis*, called by Linnæus *Quassia simaruba*, is a native of the West Indies and of the tropical parts of Continental America, and was introduced about 60 years ago to the hothouses of Britain. It is called, in Jamaica, the mountain damson. Its stem attains the height of a tall shrub or low tree; its branches are alternate; its bark is smooth and grey, variegated with yellow spots; its leaves are pinnate, and comprise each from two to nine smooth, deep green, acute-elliptic leaflets; its flowers have lanceolate petals, of a yellowish white colour; and its berries are ovate, smooth, and black. The bark of the root is imported by druggists, from the West Indies, in long pieces of a few inches in breadth; and is used, to a considerable extent, in British medicine, under the name of quassia bark. It is rough, scaly, warty, of a yellow colour within, inodorous, and very bitter; and it contains malic acid, gallic acid, malate of lime, oxalate of lime, acetate of potash, oxide of iron, alumina, a volatile oil, an ammoniacal salt, and a peculiar bitter principle called quassine. It has powerfully tonic properties; and is administered

in cases of dyspepsy, dysentery, obstinate diarrhœa, and intermittent fever.

The lofty simaruba, *S. excelsa*, called by the old botanists *Quassia excelsa*, is a native of Surinam, Jamaica, and the Caribbean Islands, and was introduced to the botanical collections of Britain in 1818. It is called in some of its native districts the bitter ash. It is a tall and beautiful evergreen tree. Its stem is straight, tapering, and smooth, and naturally rises to the height of from 40 to 100 feet, and has, in many instances, a girth of about 10 feet near the base ; its bark is grey and smooth ; its leaves are pinnate, and have reddish ribs, and comprise each from 5 to 8 pairs of opposite, oblong, pointed leaflets, and a terminating odd one ; its flowers come out in clusters, and are small and of a yellowish green colour ; and its berries are black, spherical, and about the size of pease. The wood of this species is imported in billets, and chipped or rasped by the druggists ; it is inodorous, and has a pale yellow colour, and an intensely bitter taste ; it contains much of the peculiar principle called quassine ; and it possesses similar tonic properties, and is used for similar medicinal purposes as the root-bark of the officinal species.

SINAPIA. See Mustard.

SINGLE-SEEDED CUCUMBER. See Sicyos.

SINGLING OF TURNIPS. See Turnip.

SINNINGIA. A genus of ornamental tropical plants, of the gesneria family. Six species, all small evergreen undershrubs, varying in height from 10 to 20 inches, and blooming for the most part in summer, and having flowers with some predominance of either yellow or white in their colours, have been introduced to the hothouses of Britain ; and all love a soil of peaty loam, and may be propagated from cuttings.

SIPHOCAMPYLOS. A genus of ornamental, tropical American plants, of the lobelia family. It first became known in Britain in 1835 ; and it very soon and generally acquired the fame of an eminently beautiful genus. Several of its species are very nearly allied to the true lobelias ; but others possess very distinct characters of their own, and are remarkable for both the elegance of their habit and the brilliance of their flowers.—The revolute species, *S. revolutus*, was introduced in 1839. Its stem is erect, cylindrical, villous, green, and sparingly branched, and speedily attains a height of about 5 feet ; its branches are zigzag ; its leaves are stalked, alternate, rigid, wrinkled, spreading, villous, cordate-ovate, acuminate, reflexed in the edge, simply dentate, and the upper ones revolute in the apex ; and its flowers come out on solitary, erect, axillary footstalks, and have a green, villous, turbinately-hemispherical calyx, and a purplish-red, large, tubular corolla, five times as long as the calyx.—The latana-leaved species, *S. latanifolius*, was introduced from Caraccas in 1844. Its stem is erect and shrubby ; its leaves are stalked, oval, and rather large ; and its flowers come out in terminal, many-flowered racemes, and have long, tubular, deep-crimson-coloured corollas, with five-parted, reflex, and interiorly pale pink-coloured limb, and bloom in spring. This plant has a good appearance, but is of rather weak growth.—The scarlet-flowered species, *S. coccineus*, was introduced from the Organ Mountains of Brazil about 5 or 6 years ago, and has been prominently exhibited at public shows, and greatly admired. Its stems are numerous, and have aggregately a tufty appearance, and are shrubby at the base and comparatively succulent above ; its leaves are alternate, broadly oval, doubly serrated, and glabrous ; and its flowers come out singly from the axils of several of the leaves toward the top of the stems, and are large, of a bright scarlet colour, two inches or more in length, and somewhat similar to the flowers of the tubular scarlet salvias, and continue a long time in bloom. This plant requires a moderate rich loamy soil, in well-drained, moderately-sized pots ; and must be allowed as entire repose as possible during winter.

SIPHONIA. A small genus of ornamental, tropical, evergreen shrubs, of the spurge family. The caoutchouc species, *S. cahuchu*, was introduced to the botanical collections of Britain, about 25 years ago, from Guiana. It has a height of about 6 feet, and thrives best in a soil of sandy loam, and may be propagated from cuttings. It yields some of the caoutchouc of commerce.

SISKIN,—scientifically *Carduelis Spinus*. A British song-bird of the finch group of Passerinæ. It is sometimes called the aberdivine ; and is somewhat liable to be confounded with some of the most nearly allied species of Fringillidæ. Its total length is $4\frac{5}{8}$ inches ; its bill is somewhat like that of the goldfinch ; its body is olive brown above and yellow below ; and its wings and tail are streaked with black. It arrives in Britain, from the north, in flocks, either alone, or more frequently in company with linnets and redpoles, in autumn, and remains in this country till April. It feeds on the seeds of the larch, the birch, and the alder.

SISON. See Honeywort.

SISYMBRIUM. See Hedge-Mustard.

SISYRINCHIUM. A genus of ornamental, exotic, herbaceous, evergreen plants, of the iris order. Upwards of 20 species have been introduced to Britain, from various parts of North America, between California and Brazil ; and some suit the open border, some the frame, some the greenhouse, and some the stove. All are more or less beautiful ; and the majority have a height somewhat between 3 and 25 inches, and carry either white, blue, or yellow flowers, and are most readily propagated by division. Three of the finest are the large-flowered, *S. grandiflorum*, hardy, about a hand high, carrying dark purple flowers in May and June ; Cumming's, *S. Cummingii*, a frame plant, about a foot high, carrying cream-coloured flowers from June till August ;

and the slightly hairy, *S. hirtellum*, a frame plant, 8 or 10 inches high, carrying white flowers in June and July. The name sisyrinchium signifies swine's snout, and is supposed to have arisen from the fondness of hogs for the roots of the species to which the name was originally applied, —not a plant of this genus, however, but an iris.

SITFAST. An indurated tumour on the back of a horse, occasioned by the pressure of the saddle. It generally requires to be dissected out, and should be done so gently and carefully; and if the skin of the part be horny, it also must be removed. To detach the tumour slowly by rubbing with mercurial ointment or by blistering would involve more pain and trouble, and at the same time prove less efficient, than to dissect it out; and to tear it simply off with pincers would be brutal. The name sitfast is a barbarism, yet is not undescriptive.

SITONA. See Weevil.

SIUM. See Water-Parsnip and Honeywort.

SIZE. See Glue.

SIZZING. Yeast or any similar ferment.

SKEEL. A broad flat milk dish; also a large milking pail with two vertical handles, formed by two opposite projecting staves.

SKEP. A bee-hive; also, a coarse, round, farm basket.

SKID. A chain with which the wheel of a waggon is so fastened as to prevent it from revolving on the descent of a declivity. See the article Drag.

SKILLING. A bay of a barn.

SKIM. See Plough.

SKIN. The natural covering of the body of animals. It defines the form of the body, protects it from injury, modifies the action of the surrounding elements, indicates sensation from without to the interior parts, and comprises an inconceivably minute and complex texture of organisms for the offices of touch, of exudation, of absorption, and of many of the parts or concomitants or dependencies of the highest functions of animal life. Volumes might be written to describe the wonders of the skin, and to explain how mightily and countlessly they display the wisdom and beneficence of the Creator. But we can afford, within our limited space, to do no more than give a general indication of the skin's structure,—and even this with reference only to the constitution and health of the domesticated animals.

Three successive layers constitute the skin,—first, the cuticle, epidermis, insensible skin, or scarf skin,—second, the rete mucosum, or corpus mucosum,—and third, the cutis, corium, sensible skin or true skin; and two grand provisions exist everywhere in connexion with it as concomitant systems,—first, the hair, rising up from the cutis through the cuticle to a growth on the exterior, —and second, the panniculus carnosus, spreading beneath a great portion of the cutis of quadrupeds, and possessing more power and extent in the thin-skinned and thin-haired than in the thick-skinned and thick-haired.

The cuticle and the hair have already been sufficiently noticed in the articles Cuticle and Hair. The rete mucosum is a thin, soft substance, of mucous or mucilaginous consistence, extending between the cuticle and the cutis, and comprising the intricate ramification of minute nerves and blood-vessels which connects the influences and agencies on the exterior of the body with the capacities and functions of the interior. Many of the vessels in its net-work are so minute that no magnifying power hitherto used can enable the eye to trace them to their source; and part of them are said to contain a sluggish, stagnant fluid, which constitutes the colouring matter of the skin; while others bring up from within, and pour out through the cuticle, the fluid matter of either exhalation or exudation. See the article Perspiration. "The minute vessels which supply the exhalants cannot by any physical means be traced to their insertion into the blood-vessels; and the physiology of this interesting portion of the animal economy is still in a very imperfect state; nevertheless, that these ducts are connected with the blood-vessels is proved by their becoming filled with blood on friction of the skin, or by any bodily exertion which creates perspiration, or, in man, by certain actions of the mind, such as modesty, shame, and anger." The rete mucosum of a white man is white, of a mulatto tawny, and of a negro black; and that of a white-haired horse is white, of a brown-haired one brown, and of a black-haired one black,— the rete mucosum of both man and beast being, in every instance, the seat of the colour or complexion of the body.

The cutis or true skin is a strong, elastic, fibrous, exceedingly vascular, highly sensitive, intricately organized membrane. "It appears," says Mr. Percivall, speaking of it particularly as it exists in the horse, "to consist of a dense substratum of cellular tissue, with which are interwoven fibres of a ligamentous nature, in such a manner that innumerable areolæ, like the meshes of a net, are formed in it. These areolæ open, through correspondent pores in the cuticle, upon the external surface, and are for the purpose of transmitting thither blood-vessels and absorbents, giving passage to the hair, and lodging the various secretory organs of the skin." It binds together the different parts of the horse's or ox's or other animal's frame; and is the substance which, when removed from the body and manipulated by the tanner and the currier, constitutes leather. See the articles Hide and Leather. It is thickest in the most exposed parts of the body, and thinnest in the least exposed; and it clings tightly to parts which have little or no local motion, and hangs loosely or even in folds on parts which have much local motion. "Its outer surface is garnished with numerous papillæ, which are small eminences extremely sen-

sible, lying under the cuticle, and received into its depressions; and wherever the skin is most sensible, these papillæ are found most numerous and extensive. The cutis, like the cuticle, is perforated by numerous openings, which are the exhalent and inhalent orifices,—and by the ducts of its sebaceous glands, which are in greater plenty in some parts than in others, as in the nose and ears, as well as in parts subjected to friction."

The panniculus carnosus or fleshy panicle is a remarkable muscular expansion, extending beneath a great part of the skin of horses and other quadrupeds, and serving, in many respects, as a compensation for the want of hands. "It enables them to corrugate the skin, and thus to shake off dust, prevent the attack of noxious insects, and perform other purposes necessary for their ease and convenience. In different tribes, it has different attachments; and consequently its action and powers become varied also. In the horse and all the mammalia with short hair, it is, by the extent of its attachments, capable of very powerful and diffused operations. Its centres are usually muscular, and its terminal attachments often aponeurotic, ending sometimes into other muscles or their fascias; by which, as either or any of these become the fixed point or points, the action of the whole may be changed at pleasure either partially or totally." It is everywhere very plentifully supplied with nerves, and is traversed by some which ascend through it to the skin; it is likewise well supplied with blood-vessels from the intercostals and neighbouring parts; and it has therefore much irritability and comparatively great vital power,—and may be supposed to assist the skin in bracing the portion of the frame which it covers, and probably to aid also in strengthening the muscles which are situated below.

"The skin, while the animal is alive," says Youatt, with special reference to the horse, "is one of the most elastic bodies with which we are acquainted. It not only perfectly adapts itself to the slow growth or decrease of the body, and appears equally to fit, whether the horse is in the plumpest condition or reduced to a skeleton; but, when a portion of it is distended to an extraordinary degree, in the most powerful action of the muscles, it, in a moment, again contracts to its usual dimensions. It is principally indebted for this elasticity to almost innumerable minute glands which pour out an oily fluid that softens and supples it. When the horse is in health, and every organ discharges its proper functions, a certain quantity of this unctuous matter is spread over the surface of the skin, and is contained in all the pores that penetrate its substance, and the skin becomes pliable, easily raised from the texture beneath, and presenting that peculiar yielding softness and elasticity which experience has proved to be the best proofs of the condition, or, in other words, the general health of the animal. Then, too, from the oiliness and softness of the skin, the hair lies in its natural and proper direction, and is smooth and glossy. When the system is deranged, and especially the digestive system, and the vessels concerned in the nourishment of the animal feebly act, those of the skin evidently sympathize. This oily secretion is no more thrown out; the skin loses its pliancy; it seems to cling to the animal, and we have that peculiar appearance which we call hide-bound. This, however, requires attentive consideration. We observe a horse in the summer. We find him with a thin smooth glossy coat, and his extremities clean and free almost from a single rough or misplaced hair. We meet with him again towards the winter, when the thermometer has fallen almost or quite to the freezing point, and we scarcely recognise him in his thick, rough, coarse, colourless coat, and his legs enveloped in long shaggy hair. The health of the horse is, to a certain degree, deranged. He is dull, languid, easily fatigued. He will break into a sweat with the slightest exertion, and it is almost impossible thoroughly to dry him. He may perhaps feed as well as usual, although that will not generally be the case, but he is not equal to the demands which we are compelled to make upon him. This process goes on for an uncertain time, depending on the constitution of the animal, until nature has effected a change, and then he once more rallies. But a great alteration has taken place in him—the hair has lost its soft and glossy character, and is become dry and staring. The skin ceases to secrete that peculiar unctuous matter which kept it soft and flexible, and becomes dry and scaly; and the exhalents on the surface, having become relaxed, are frequently pouring out a profuse perspiration, without any apparent adequate cause for it. So passes the approach to winter, and the owner complains sadly of the appearance of his steed, and, according to the old custom, gives him plenty of cordial balls,—perhaps too many of them,—on the whole not being unserviceable at this critical period, yet not productive of a great deal of good. At length the animal rallies of himself, and although not so strong and full of spirits as he ought to be, is hardier and more lively than he was, and able to struggle with the cold of the coming winter. What a desideratum in the management of the horse would be a course of treatment that would render all this unnecessary? This desideratum has been found—a free escape of perspiration, a moist and softened state of the skin, an evident increase of health and capability of enduring fatigue, and working on shorter supply of food than he could before. This is said to be performed by the clipping and singeing systems."

SKIRRET, — botanically *Sium Sisarum*. A hardy, tuberous-rooted, culinary plant, of the umbelliferous order. It is a native of China,

and was introduced to Britain about the middle of the 16th century. The root comprises several fleshy or tuberous fibres, as large as a man's little finger, which join together in one head; the stalk is about a foot high; the lower leaves are pinnate, each comprising two or three pairs of oblong leaflets, and a terminating odd one; the flowers grow in an umbel on the top of the stem, and are white, and bloom in July and August; and the seeds are striated like those of parsley, and ripen in autumn. This plant is raised either from seeds sown in drills in spring, with a subsequent thinning out of the plantlets to distances of 6 inches, or from side offsets of the old roots, planted in spring and in autumn. The roots were formerly mentioned in old dispensatories as medicinal; and were long esteemed wholesome, nourishing, and agreeably culinary, and were boiled and eaten whole in summer, autumn, and winter; but they are now used scarcely ever for medicine, and very seldom even for food; for they are flatulent and very sweet and unpleasant to many palates.

SKOVES. Bundles of corn or unbound sheaves.

SKULL. See HEAD.

SKULLCAP,—botanically *Scutellaria*. A genus of ornamental herbaceous plants, of the labiate order. Two species grow wild in Britain, about 30 have been introduced from other countries, and a good many more are known. All the introduced species, except two evergreens from Australia and Havannah, are hardy, annual-stemmed perennials; most have a height of between 6 and 25 inches; the majority have blue-coloured flowers; and seven produce their flowers solitarily from the axils, two spicately and racemosely from the axils, two compoundly and racemosely from the summit, and the rest simply and racemosely from the summit. The name scutellaria signifies 'a little saucer,' and alludes to the form of the calyx.

The common or small-capped skullcap, *S. galericulata*, inhabits the ditches, the reedy river margins, and other watery situations in many parts of Britain. Its root is creeping; its herbage has a deep green colour, often tinged with violet, and is more or less downy; its stem is erect, leafy or branched, and from 10 to 20 inches high; its leaves stand on very short footstalks, and are heart-shaped at the base, lanceolate, crenate, rugged, somewhat wrinkled, and upwards of an inch long; and its flowers are axillary, solitary, almost sessile, drooping, about an inch long, scentless, variegatedly blue throughout with streaks of white on the lip, and bloom from June till September.

The lesser skullcap, *S. minor*, inhabits moist hedges, and similar situations in Britain. Its stem is more branched than that of the common species, but only about 6 inches high; its leaves are broader than those of the common species, and almost of a hastate form; and its flowers grow in the same manner as those of the common species, but are smaller, and have a delicate pink colour almost inclining to blue, and bloom in July and August.

Some of the most handsome of the introduced species are *S. hastifolia*, 6 inches high, with axillary, solitary, purple flowers, from Germany,—*S. lateriflora*, a foot high, with racemose, axillary, blue flowers, from North America,—*S. alpina*, 9 or 10 inches high, with simply racemose, terminal, blue and white flowers, from Hungary, but comprising blood-red-flowered and variegated-flowered varieties from other countries,—*S. altissima*, 12 or 15 inches high, with simply racemose, terminal, dark purple flowers from the Levant,—*S. peregrina*, 2 feet high, with simply racemose, terminal, violet flowers, from Italy,—and *S. pilosa*, a foot high, with compoundly racemose, terminal, blue flowers, from North America. These species and many others are well suited to adorn the front of the open border; and they thrive in any common garden soil or in a peaty loam, and may be propagated either from seeds or by division.

SKY-LARK. See LARK.

SLAB. The outside plank of a log or boll of timber when sawn into boards; also a flat thin piece of marble or of other compact stone.

SLATE. A thin slab of any kind of rock of a compact texture and laminated structure, which splits into desirable thicknesses for the purpose of covering roofs. All the stratified rocks, whether primitive or transition, secondary or tertiary, which admit of being split, are comprehensively called slate rocks,—and they may be very variously classified according to the several theories of science and the several designs of economy; but the argillaceous schists, or those rocks which furnish the best roofing slates of commerce, such as the blue clay schists of Wales and of the Western Highlands and Islands of Scotland, take the name of slate rocks par excellence.

The transition slate-rocks form the substrata and even the soil of a large portion of the well-farmed districts of Scotland, as well as of some most interesting parts of Ireland and of Wales; and they demand some special study on the part of farmers, on account of the difference of their constitution from that of the other prevailing rocks of the arable surfaces of Britain, and on account too of wide differences of constitution among themselves. They need to be well understood, especially, in reference to the paucity and the very variable proportions of their lime. Professor Johnston, speaking of specimens that were gathered from the great greywacke formation of the south of Scotland, and subjected to analytical examination in his laboratory, says:—"Many of them were traversed by white hair-like streaks of carbonate of lime, and nearly all of them exhibited a slight effervescence when treated with acid, showing that they contained traces of lime in the state of carbonate. The results of the analyses of seven varieties were as follows:—

	1.	2.	3.	4.	5.	6.	7.
Lime in state of carbonate, per cent.,	7·19	0·26	1·98	0·25	0·22	....	0 19
Lime in state of silicate,	0·24	0·62	0·30	1·09	0·43	0·50	....
Total lime per cent.,	7·43	0 88	2·28	1·34	0·65	0 50	0·19

The proportion of lime, therefore, in the different beds of this formation is small. In general, therefore, the soils formed from them will be deficient in lime; and hence the reason why in practice it has been found that the addition of lime is an almost necessary preliminary to any successful and permanent improvement of the surface where these soils prevail. At the same time, it will be seen by the composition of No. 1 that some beds contain what may be called a large quantity of lime, and will therefore form soils that are of a richer character. The waters also that percolate through them, or the springs that rise from among them, will contain a considerable quantity of lime, and they may both sweeten the natural herbage, and when they collect in lakes and marshy places, may yield lime enough to admit of the gradual deposition of beds of marl.—The old red sandstone slates also vary in the proportion of lime they contain. Such a slate from Fotheringham estate in Forfarshire gave—

Lime in the state of carbonate,	0·39 per cent.
Do. do. silicate,	0·87 "
Total lime,	1·09 per cent.

The known fertility of certain soils belonging to the old red sandstone formation does not depend merely on the proportion of lime they contain; yet, in the less fertile parts of this formation, the per centage of lime contained in the rocks exercises a material influence on the agricultural capability of the soils which rest upon or are formed from them."

SLATING. In England where slates are very generally used for covering the best buildings, they are split and cut at the quarry into square plates, and are sold and distinguished by the following singular names, depending on their quality and size.

Doubles, are	1 ft. 2 inches	by 0	6
Ladies,	1 ,, 3 ,,	by 0	8
Countess's,	1 ,, 10 ,,	by 0	11
Duchess's	2 ,, 2 ,,	by 1	3
Queen's (also called Rags),	3 ,, 3 ,,	by 2	3
Imperials and patent,	2 ,, 8 ,,	by 2	2

They are sold by the 100. The quantity necessary to cover a square of roofing of the first four kinds will weigh from 6 to 7 cwt. The large slates being also thicker will weigh from 7 cwt. to a ton. The word *patent* applies to the mode of fixing and not to the slate. Slates, from their being thin and brittle, require a certain degree of skill in the cutting, making the nail holes, and laying, so as to prevent waste, and on this account their use is considered a separate branch of business, and is performed by the slater. Iron nails are used to fix shingles, and endure as long as the shingles will last; but as good slates may be considered everlasting (unless broken or injured by accident), they ought to be fixed with copper nails, that do not rust away. Roofs are occasionally covered with sheet lead, copper, or zinc, in all which cases they must be covered with planed boarding, and the long joints in the metal should be vertical, and not soldered, but so constructed as to admit of expansion and contraction.

SLAUGHTERING. See MEAT.

SLEDGE. A slide-car or drag-cart. See the article CART. An improved sledge, for carrying turf, hay, or other heavy commodities down slopes which are impracticable for any wheeled vehicle, may be made with iron-shod ash or elm soles, and ash rail body of 4½ feet square or so at bottom, and drawn by chains of 7 feet in length, and bar-iron stilts of 5 feet in length, aided by a small friction wheel. A figure and plan and details of such a machine are given by Mr. Cook of Yetholm in the 8th volume of the Highland Society's Transactions.

SLENDER-BODIES. See GEOMETERS.

SLINKING. See ABORTION.

SLEEP. The phenomena of sleep bear an immediate relation to the most general laws of Nature, and form an important illustration of the fact, that the periodical motions of the animal economy are in direct correspondence with the movements of our planetary system, and especially with our situation relative to that sun which regulates the periods of the day and year. "All our wants reappear," says Cabanis, "and all our functions execute themselves, in fixed and isochronous periods. The duration of the functions is the same in each period; the same appetites or the same wants have the hours marked for their return; and it commonly happens, when these wants are not immediately satisfied, they diminish and disappear for a certain time, only to return again with the greater force and importunity at the next succeeding period, which ought to produce a return of the impression. This character of periodicity is particularly remarkable in the returns and duration of sleep, which commonly reappears during each astronomical day at the same hour; continues nearly for the same period of time; and according as it is regular in its periods, slumber is the more easy, while the repose which follows is the more salutary and refreshing."

There are two principal states of vital activity, of which all animals partake in different degrees. When the vital excitement exists to its full extent, the animal is said to be *awake;* when the functions of life are suspended, either wholly or partially, it is said to be *asleep.* From this waking state, when life exists in all its plenitude, there may be many degrees of its diminution, called *reverie*, *delirium*, *dreaming*, *sleep*, *torpor*, *stupor*, *asphyxia*, *lethargy*, according to their intensity, of which states the last is but one degree removed from absolute death.

The principal occasions on which these states of vital repose naturally present themselves to our observation are, 1st, When the body and

mind of an animal languish either from the return of their period of natural repose, or through excessive exertion. 2d, When the cold of winter, or perhaps also the heat of summer, acting on special constitutions, suspends the animal functions of life either partially or entirely. The former phenomenon appears daily, while the latter is of annual recurrence.

The first of these occasions, or sleep properly so called, differs from death, with which it has often been compared, in the circumstance that all the involuntary functions of life continue their action uninterruptedly. It may be recollected that animals have two kinds of vital functions; the one vegetative and internal, which continue, with the exception of generation, to exert themselves during the entire existence of each individual, and the other purely animal, which refer to external objects. The former being essential to their existence, are never suspended; the latter are intermittent in their action. If the heart ceased to propel the blood through the arteries, if the lungs ceased to respire air, if the functions of nutrition and secretion were discontinued, or if they depended upon the mere will of the animal, life would soon become extinct. But all these internal actions are involuntary, and hence it is only the external and purely animal functions of life which can have their periods of action and repose, of waking and sleeping. These latter actions are therefore less essential to life than the former. An animal, when profoundly asleep, is reduced to a state very analogous to that of a plant. Though dormant, he is still a living being, for he continues to perform the functions of nutrition and secretion even more perfectly than when awake; but he is destitute both of sensation and motion, and must awake before he can fully resume these functions peculiar to animals. Thus animals have two states of existence, waking and sleeping, while a plant has only one. The state of the latter may, however, be more or less active, according to the different degrees of heat or light to which it is exposed. There can be no difference with plants between the activity of the internal and external functions, and they always appear to be plunged in a state of repose more or less profound. Many of the lower animals, such as an oyster or a zoophyte, when considered superficially, appear to exist in a continued state of torpor, rather than to possess an active life, because they maintain but few relations to external objects, and hence are commonly considered rather as vegetating than as living, although plants are possessed of life as well as animals, but only in different degrees.

Sleep, in fact, consists in the suspension of the organs of sense and voluntary motion, qualities which chiefly serve to distinguish animals from plants. All the voluntary muscles repose completely, and the sleeping animal maintains no active relations with external objects. The functions belonging to vegetable life continue their existence, but the consciousness of existence is lost. The heart and the lungs continue to act without interruption, while the organs of thought and sensation possess but a temporary action. It is thus precisely those organs which are the most intimately connected with the mind, namely, the organs of thought and sensation, which most require repose, and the human soul, though immortal, when entirely separated from the body, cannot now maintain its consciousness uninterruptedly for twenty-four hours together.

Night, or the absence of light, is favourable to the sleep of all animals not naturally of nocturnal habits. Silence, repose, the absence of noise, and in general every thing which interrupts the relations of the animal with external objects, are favourable to sleep. As long as the purely animal functions continue to be stimulated, they maintain their action, until an excess of action produces a contrary effect. A violent exertion of the body, profound thought, or any powerful sensation, disposes for sleep. Often the fatigue of a single sense brings on the sleep of all the senses, through that intimate connexion maintained among all the parts of the body. The monotonous murmurs of a brook, the howling of a forest, bad music, protracted reading, bad verses, or a long lecture on an uninteresting subject, gradually fatigue the sense of hearing or sight, and lead the vital forces of these organs to seek in sleep for an accession of energy, and the repose of the entire animal functions speedily follows.

The inclination to sleep is announced by a slowness of motion, by languor of the attention and will, and by the gradual stupefaction of the senses. But the different kinds of functions are suspended in a certain order of succession, according to their nature and relative importance. The muscles which move the arms and legs are relaxed and cease to act before those which sustain the head, and the latter before those which support the spine. When the sense of sight is first suspended by the falling of the eyelids, the other senses still maintain their action. The sense of smelling is obliterated before the taste; hearing after smelling; and touch last of all. Even during the most profound sleep, the sense of touch continues to suggest different movements and changes of position, when the long duration of the same posture renders it disagreeable. At length animal exertion is at an end; the muscles, excepting those of circulation and respiration, cease to act; and the body sinks down, obedient to the ever-acting force of gravitation.

These phenomena of sleep are very analogous to that insensibility of particular organs, during our waking moments, when the attention is fully engaged. A profound mathematician, when absorbed in a calculation, neither sees, hears, nor feels; all the functions are asleep except the

organ of thought. Other men, like mere machines moved by habit, perform the same operation a thousand times with their hands, while the thinking principle remains buried in a profound lethargy.

At the precise moment when the mind loses its consciousness, there results a general relaxation of all the muscles. If the body be at rest and in health, this sudden change in its state of obedience to the will is attended with no marked result. But if the body be fatigued, or in an uneasy posture, or if the joints or muscles be painful, this first result of sleep has the effect of removing it entirely. Hence arises the difficulty of sleeping in a sitting posture, or during an attack of gout or rheumatism. The pain which the sudden starting of the muscles occasions is often so great in these diseases, that sleep can only be induced by strong doses of opium or some other narcotic. It also follows from this relaxation of the muscles, that the limbs become bent during sleep, and that a substance grasped firmly in the hand, falls at the instant when consciousness is lost. During sleep the character of the respiration is altered; it becomes less frequent and deeper. The heart also beats more slowly, but the pulse is stronger. The heat of the surrounding air, when imperfectly renewed, tends, however, to increase its movements. The heat of the body is not naturally higher during sleep; on the contrary, a diminished respiration tends to lower the temperature. It usually happens, however, from external circumstances, that there is an apparent rise of temperature, from the body being surrounded by imperfect conductors of heat, and from the circumambient air being but slowly renewed.

As the stomach is a muscular organ, and as the passage of the food through the pylorus depends upon the rapidity with which the almost insensible contractions of the stomach are performed, it follows that sleep retards digestion, while, at the same time, it renders it more complete. This slowness of digestion is further increased by the state of rest in which the body remains, as nothing tends more to excite a rapid digestion than the gentle motion of the limbs, or of the entire body. The same phenomena take place in the intestines, where the aliments remain almost inert in the several portions of the alimentary canal. However, the slowness of this movement favours the formation of chyle, and renders its absorption more complete.

Absorption is very active during sleep, and the danger of slumbering in noxious air hence becomes very great. Travellers are usually advised to avoid sleeping in marshy situations, such as the Pontine marshes of Italy, especially in the warm season of the year. Perspiration also is performed more easily, because the pores remain open during the state of muscular relaxation. "Une nutrition plus efficace, la réparation graduelle des forces qui en résulte, et aussi la réplétion de la vessie, toutes ces choses réveillent en nous, durant le sommeil, des idées de jouissance et des souvenirs de volupté." As all the senses do not fall asleep at the same time, so they differ in the order in which they awake. Taste and smell commonly resume their functions last of all. The sense of sight is roused with greater difficulty than that of hearing. An unexpected noise will often awaken a somnambulist from his lethargy, upon whom the strongest rays of light will have had no previous effect, although his eyes continue open. Touch, as it was the last sense to become dormant, so it appears to be the most easily roused. The same person who cannot be awakened by very loud noises, will rise instantly on being gently tickled on the soles of the feet. Often the mere approach of the respiration of another will be sufficient to rouse the soundest sleeper.

The positions which the mammalia assume during sleep are very various. The young animal sleeps with its limbs gathered together, in a posture most resembling that of the fœtus in the womb. This situation is very favourable to the renewal of the animal forces, by permitting the relaxation of all the articulations, and in preserving the heat of the more sensitive parts. For the latter reason, the dog and cat sleep with their bodies formed into a circle. Some mammalia sleep in the open air, while others retire to caves and sheltered places. Many repose without any covering, while others prepare a bed of some imperfectly-conducting substance, to preserve the temperature of their bodies, which would otherwise fall during sleep below the natural standard. It is usually on the right side that man reposes. This posture favours the action both of the heart and stomach, as the vibrations of the former would reverberate through the body from the reaction of the substance upon which it reposes, and the latter would be compressed by the weight of the liver. After sleep, all the organs, being refreshed, repaired, and completely nourished, acquire a greater size; thus man and other animals which commonly hold the spine more or less erect, are taller in the morning than in the evening after the fatigues of the day.

Sleep is not always profound; some of the animal functions continue to act; ideas succeed each other, and the animal is said to dream. The power of dreaming is falsely ascribed to man alone; other mammalia dream likewise, because they are capable of thought, and possess a certain degree of intelligence. Sometimes the dog is observed to howl, struggle, and perspire copiously. Moving his tail and limbs rapidly, he pursues the hare in imagination, and, on the point of seizing it, closes his teeth and lips as if in the act of dyeing them in blood. Some birds are also known to dream, as the parrots. Those animals which are most easily excited dream more frequently than the others; thus the horse

is more liable to dream than the bull. According to Chabert, this phenomenon among cattle is only observed in the bull, the ram, or in cows which are suckling.

It is possible to protract the usual period of sleep by an unusual excitement; but if the stimulus be long continued its effect goes off, and then nothing can prevent sleep as long as the health continues good. In fact, sleep, once in the twenty-four hours, is as essential to the existence of the mammalia as the momentary respiration of fresh air. The most unfavourable conditions for sleep cannot prevent its approach. Coachmen slumber on their coaches and couriers on their horses, while soldiers fall asleep on the field of battle, amidst all the noise of artillery and the tumult of war. During the retreat of Sir John Moore, several of the British soldiers were reported to have fallen asleep upon the march, and yet they continued walking onwards. The most violent passions and excitement of the mind cannot preserve even powerful minds from sleep; thus Alexander the Great slept on the field of Arbela, and Napoleon upon that of Austerlitz. Even stripes and torture cannot keep off sleep, as criminals have been known to slumber on the rack. Noises which serve at first to drive away sleep, soon become indispensable to its existence; thus a stage-coach stopping to change horses, wakes all the passengers. The proprietor of an iron forge, who slept close to the din of hammers, forges, and blast furnaces, would awake if there was any interruption to them during the night; and a sick miller, who had his mill stopped on this account, passed sleepless nights until the mill resumed its usual noise. Homer, in the Iliad, elegantly represents sleep as overcoming all men, and even the gods, excepting Jupiter alone.

The length of time passed in sleep is not the same for all men; it varies in different individuals and at different ages; but nothing can be determined from the time past in sleep, relative to the strength or energy of the functions of the body or mind. From six to nine hours is the average proportion, yet the Roman Emperor Caligula slept only three hours, Frederic of Prussia and Dr. John Hunter consumed only four or five hours in repose, while the great Scipio slept during eight. A rich and lazy citizen will slumber from ten to twelve hours daily. It is during infancy that sleep is longest and most profound. Women also sleep longer than men, and young men longer than old. Sleep is driven away during convalescence after a long sickness, by a continued fasting, and the abuse of coffee. The sleepless nights of old age are almost proverbial. It would appear that carnivorous animals sleep in general longer than the herbivorous, as the superior activity of the muscles and senses of the former seem more especially to require repair. Satiated with their prey, they are obliged to seek repose to digest those very substantial matters which compose their aliment.

In general, it may be stated, that during sleep the internal functions predominate over those relating to the exterior of the body. Every thing which tends to interrupt the relaxations of the external with surrounding objects serves to induce sleep. On the contrary, the existence of external stimuli tend to expel it, until at length they lose their effect by long-continued exercise. From this it ought to follow that excessive cold, which benumbs the external powers, ought to occasion sleep. When exposed to the action of a low temperature, animals experience an irresistible desire to sleep which soon terminates in death. Of this there are frequent examples in the inhospitable climates of the north, Siberia, Lapland, and Kamtschatka, or on the tops of high mountains, as the glaciers of Switzerland. Dr. Solander and party nearly lost their lives from this cause among the hills of Terra del Fuego. Surprised by an excessive cold, he was with difficulty prevented by his companions from yielding to this impulse of nature, although knowing well the consequences of sleeping. Travellers on horseback are peculiarly liable to be overcome by this propensity to sleep, when the cold is very intense, in which case they are sure to be frozen to death.

There prevails among many mammalia a singular internal modification, which cannot be explained by any cause more general than itself, but must be referred to some unknown original constitution. We refer to that state of torpidity commonly called Hybernation. See that article.

SLIPPER-PLANT,—botanically *Pedilanthus*. A genus of curious, South-American, evergreen undershrubs, of the spurge order. Six or seven species, all about 20 inches high and apetalous, have been introduced to the dry stoves of British gardens. They thrive in any common soil, and are propagated from cuttings. The name alludes to the flower.

SLIPPERWORT. See Calceolaria.

SLIPPING. See Abortion.

SLIT-PLANTING. See Planting.

SLOANEA. A genus of tropical ligneous plants, of the lime-tree order. The tooth-leaved species, *S. dentata*, is a South-American evergreen timber-tree, of commonly about 40 feet high, and was long ago introduced to the botanical collections of Britain. Seven other species are known.

SLOE-TREE. See Blackthorn.

SLOUGH-HEAL. See Self-Heal.

SLOUGH-IN-THE-EYE. See Inflammation.

SLUG,—scientifically *Limax*. A group of small, creeping, soft-bodied animals, constituting, together with the snail or helix group, the terrestrial, pulmonious, gasteropodous family of molluscs. Both groups, or at least some very abundant species of them, are well known to gardeners and farmers for their extensive depredations on herbaceous cultivated crops. The most common

slugs are *Limax agrestis*, of a greyish colour, without any spots, and from one inch to two inches long,—*Limax cinereus*, of a greyish or dusky colour, with spots or stripes of a darker hue, and from 3 to 5 inches long,—and *Limax ater*, of a jet black colour, and wrinkled on the back, and very commonly crawling about in wet weather; and the most common snails are *Hilex aspersa*, which has a dull coloured shell, marked with three faint mottled brownish bands, and a white rim round the aperture, — and *Hilex hortensis*, which is much smaller than the preceding, and has a glossy shell with distinct bands of vivid colours, and a brown rim round the aperture, and which, in spite of its name of hortensis, frequents the field much more than the garden.

Slugs and snails differ from each other in the latter having shells and the former not; and they agree in shape, in general conformation, and even in most of their minute characteristics. They have four tentacula placed in front of the head, and which, by a singular process of inversion, can be drawn entirely within it. The superior pair are always the longest; and they carry near the tips, but a little on one side, each a small eye, by which the animals distinguish objects nigh at hand. With the inferior pair, they feel and try the road which they have to travel. Between and under this pair is situated the mouth, guarded by two swollen lips, in which, perhaps, the sense of taste may reside. The mouth is armed above with a semilunar horny jaw, placed transversely, and having its outer or cutting edge furnished with one or several serratures. Within the mouth, stretched upon a protuberant, fleshy, buccal mass, the tongue is laid, shaped somewhat like the bowl of a spoon, and consisting of a thin membrane reticulated in a manner so exquisitely regular and minute, that no one can examine it without admiration. On the right side, or neck, of the slug and snail there are three apertures. "The largest, which is the respiratory orifice, is situated at the edge of the shield: the second is at the posterior and upper margin of this first orifice; it is the anus: the third is either placed directly under the pulmonary opening, or immediately behind the upper tentaculum; it is the exit for the organs of generation." The skin is soft, and lubricated with a viscid mucus, which is secreted most copiously when the animals are in motion; and running down on the ground, it serves to smooth the way, and leaves a glistening tract behind, which may lead to the discovery of their retreats. They are strictly gasteropodous, crawling at a slow pace on the flat sole which constitutes their foot and belly. This foot is very muscular, and all its fibres aid in the act of locomotion; but progression is principally performed by a pair of muscles which extend from the tail to the fore part, running along the middle of the foot. On opening the cloaks, they are seen projecting on the interior surface of the foot as two raised lines, larger before than behind. By putting a slug into a bottle partly filled with water, the regular contractions of these longitudinal muscles may be distinctly seen, recalling to recollection the apt comparison of Swammerdam, — "following each other like the waves and billows of the sea." These animals are hermaphrodite and oviparous. They deposit their eggs under clods of earth, loose stones, or in the ground, in which the parent digs with its foot a circular hole, about one inch deep. The eggs vary from twelve to thirty in number; they are white, oval or round, about the size of a common shot, with a smooth soft skin, which is entirely membranous in the slugs, but in the snails contains innumerable minute calcareous grains always in a crystalline state, and usually of a rhomboidal figure. They are, in ordinary seasons, hatched in about three weeks after being laid, but the time is regulated much by temperature, so that in cold seasons it is greatly retarded. The young issue from the egg in the likeness of their parents, active, and furnished with every organ; and the young snails have even then a shell fitting their size and strength. To what length of years the life of a snail or slug is prolonged has not been determined. It is a gross error to suppose that the marks on the shell, which indicate the successive stages of its growth, indicate also the tenant's age; every space between two such marks being said to be formed in one season. This is not the case. These creatures are very patient of injury, recovering after the cruellest wounds; and they are capable of repairing their broken shells, and of reproducing such parts of their body as may have been cut away in the perils to which they are exposed. In winter, they retire under stones and clods, or into crevices of walls. The slugs become merely less active and more hebetous than usual; but the snails properly hybernate; and to protect them from annoyance during this dead sleep, of a winter's continuance, they seal up the apertures of their shells with a horny membrane.

The natural uses of the slug and the snail appear to be, to serve as food for reptiles, birds, and the smaller quadrupeds, such as foxes, badgers, weasels, hedgehogs, &c. The blackbird and the thrush are remarkably fond of them; and may be seen flying off with snails in their bills, and breaking the shells against stones or the branches of trees. There is some apparent reason for supposing that the worm is more useful than injurious to plants, but none that we know of as far as respects the slug or the snail. These animals retire under the cover of foliage or some other protection from the sun and dry air during the day, and come abroad to feed during the night, after rain, or when the weather is cloudy. They select, in preference, tender seedling plants, or the leaves of maturer plants which have become tender and somewhat sweet by incipient decay. They are very fond of greasy

matter, and where a snail has been killed by crushing, its remains attract numbers to feed on it.

To destroy snails in gardens, the only effectual mode is hand-picking, either in the evening or early in the morning, or immediately after rain. Empty flower-pots, reversed and distributed over the surface, if an opening is left on the side, by making a small depression in the soil, will attract a great number of snails; and the more so, if some greased cabbage leaves be placed under the pots. In the course of the autumn, winter, and early in the spring, all their hiding-places should be searched, and the animals taken out and destroyed by crushing or by giving them to swine, which are said to be very fond of them. Hedgehogs and weasels, being their natural enemies, may be kept in gardens; and poultry which do not scratch, such as turkeys, ducks, &c., may be admitted occasionally; though no mode of subduing the snail but hand-picking is to be depended on.

Slugs in gardens are destroyed with less labour than snails; because, their bodies being comparatively unprotected, they are liable to be operated on by any caustic or bitter liquid as readily as worms. Cabbage leaves in a state of incipient decay, with the side which is to be placed next the soil rubbed over with greasy matter of any kind, or even with the bruised bodies of recently killed slugs, distributed over any surface, will attract them in great numbers during the nights; and if the blades are examined every morning, and the slugs which are found destroyed, the piece of ground so treated will soon be freed from them. Pea haulm being very sweet when in a state of incipient decay, forms a powerful attraction to slugs; and if handfuls of it are distributed over a piece of ground in the same manner as cabbage leaves, the little heaps of haulm may be examined every morning, and the slugs shaken from them, and then destroyed by watering with lime-water. Thin slices of turnips or potatoes, placed under inverted empty flower-pots, form an excellent attraction, as do the dead bodies of slugs themselves, some parts or the whole of which are greedily devoured by the living animals. Where slugs are very abundant in a soil not covered with plants so large as to shelter them, as for example with rising seeds, the slugs may be destroyed by watering the soil thoroughly with lime-water or tobacco-water, late in the evening or early in the morning. Abundance of water should be applied, in order that it may sink into the soil, which the slugs penetrate one foot or more in depth, according to its state of pulverization. Quicklime has been laid round plants to protect them from snails and slugs, but it soon becomes mild, and of no use as a protection. Coal ashes and sawdust annoy slugs by sticking to their feet; but they will not be deterred by this annoyance so effectually as to starve for want of food. Soot is also a great annoyance to slugs; but, to keep them from a plant, it requires to be frequently and liberally renewed. "A stout, coarse, horse-hair line, such as is used for hanging clothes out to dry, coiled round the stems of wall-fruit trees, and stretched along the wall will operate as a protection to the fruits from both snails and slugs, in consequence of the bristly surface presented to them, and which they shrink from encountering. Care must, of course, be taken that they do not get under it."

No gardener ought to rest content with merely protecting his plants or fruits from snails or slugs; because, while they are in the garden, as they must live, if they are debarred from attacking one plant, they will only have recourse to another. Nothing short of extermination, therefore, ought to satisfy him; and this he may accomplish by enticing the larger slugs into empty pots, or under cabbage leaves or haulm, and by soaking thoroughly with lime-water the soil which he supposes to contain young slugs or eggs.

The destroying of slugs in fields may be effected by widely different means, and ought, in each particular case, to be attempted by whatever one of these may be most economical in itself and most suitable to the kind and condition of the crop. A good powdering of quicklime on turnips and some other crops, in places where lime is cheap and has not already been over-applied, is a very ready and perfectly efficient means. An aspersion with lime-water, especially after nightfall, may be eminently suitable in the case of some kinds and conditions of crop where quicklime might do harm. A sprinkling of tar-water or of the liquid refuse of gas-works is also effective. The turning in of a large flock of geese, ducks, or other similar feeding fowl is, in some circumstances, the easiest and cheapest method. And an application of common salt may be hopefully made in almost any case, or as a pretty sure resource when any less expensive means is unsuitable or cannot be obtained.

To prevent the appearance of slugs, however, is far better than to destroy them; and may, in general, be more or less certainly effected by the easy expedient of early ploughing. "It would be of some importance," says an intelligent provincial writer, "to know whether the slugs which injure the corn arise chiefly from between the furrow slices in the corn field, or whether they chiefly come from the neighbouring grass fields to the corn. The fact that slugs, as far as I know, never injure corn after fallow, but always after lea or clover, seems to favour the former supposition; but the injury done in gardens by them, where they must come chiefly from without, seems to favour the second hypothesis. The most important indisputable fact is, that they injure only the tenderest blades. After warm and showery weather in May has caused a rapid growth, the corn blades are very tender, and the slug finds them a pleasant food. The tenderness

of the plants is greatest when they are very young. Hence late plants, which have rapidly sprung up under the heat of May, will be more tender than plants which formed their leaves earlier when less heat and moisture were present. This shows the importance of early sowing, especially on lea, if it puts the plants beyond the reach of the slug. But again, the fact that wheat after fallow is not infested, while wheat after lea, or clover, or beans, is sometimes nearly destroyed by slugs, bears in upon the mind the conviction that the slug arises from the soil on which these crops grew. It would lead one to conclude that they, like the grubs, lay their eggs in the soil where they fed during the former season, and that these eggs yield young slugs at some very early period in the season. The fact of my finding many slugs, no bigger than large pin heads, in the grass in February, favours this notion. The inference from this is, the importance of early ploughing for spring crops. Early ploughing, where the ground is exposed to the winter frost, is a substitute for lea fallow to a certain extent. And where wheat is sown early, and after ploughing lea or clover, the plants rise before the ground has had the advantage of this partial fallow. The practice of grazing sheep in winter tempts us to defer ploughing our lea as long as possible. This must be very bad economy if the above views be at all correct; for all that we can gain from them by winter pasture will not exceed 6s. or 7s. per acre at farthest,—and in seeking to gain this, we may lose ten times as much by the grub and slug in our next crop; and it is hardly possible to conceive that our loss will ever be so little as double the gain from pasturage."

SMALLAGE. See Celery.

SMALL-POX. This disease has lately been making great ravages among the sheep of Britain. The form of it which attacks sheep, and which is called by the learned *Variola ovis*, has long been known and dreaded on the Continent, and seems to have been recently imported thence into this country. The Marquis of Salisbury in Hertfordshire speedily lost nearly 2,000 sheep by it; some of the farmers of Norfolk soon lost 50 per cent. or even a larger proportion of their flocks; and the farmers of some entire districts have felt themselves exposed to so much danger, by the diffusion of the epizootic from diseased sheep in the public markets, as to be compelled to sell their stock only on their own farm, and to refrain from either selling or purchasing at fairs. But on account of the consequent embarrassment which has occurred to the sheep-trade, as also on account of the risk occasioned to the public health by sending diseased sheep to the shambles, and likewise on account of the contemporaneous prevalence of pleuro-pneumonia among cattle, the attention of the Legislature has been drawn to the sanitary condition of the live stock of the country, so that public facilities will henceforth be afforded to prevent the spread of contagion. In Germany, the law directs all owners of flocks affected with small-pox, not only to tell the fact to their neighbours, but to proclaim it in the newspapers; and so stringent a provision was probably suggested by the fact, that any sheep, on passing from an infected district to an uninfected one, may carry abroad and widely diffuse the virus of the malady before any symptom of the existence of it in its own body can be observed.

All persons engaged in sheep husbandry ought to acquaint themselves well with the symptoms and proper treatment of small-pox in sheep, both that they may avoid purchasing diseased animals, and that they may know what to do if it should break out among their flocks. We shall, therefore, present one account of it by a German agriculturist, and another by a very experienced veterinary surgeon of Hamburg. "In this disease," says the former, "the sheep suffer previously internally, with a loss of appetite, heaviness, and indisposition to move, difficulty of breathing, swelling of, and discharge from, the eyes, and of a viscous matter from the nostrils. In from three to five days, spots appear on the bare parts of the legs and body, which become large, and form blisters, in the centre of the red circumference of which yellow spots come, and at last fill with yellow matter. If these spots become blue or blackish, they unite, and a thin stinking matter issues from them, which is the height of the disease; but death ensues if the pustules should not come properly out, or should strike in again. The last stage of the disease, when it terminates favourably, is marked by the drying away of the sore, on which a black scurf forms and falls off. The animal has the disease, as with man, only once; in a flock it is contagious, but not so among cattle. During this disease, good hay and drinks of a decoction of barley are good, to which a little common salt may be added. At the commencement of the disease, the nose and mouth must be kept clean with vinegar and water, the eyelids are to be often washed with warm milk, and an electuary, of three-parts of flower of brimstone and one part common salt and honey, is a useful remedy. But I am of opinion that inoculation of the whole flock the moment the disease shows itself, even in one in the neighbourhood, is the only preservative." The surgeon of Hamburg says:—"The first symptoms are, that the animal becomes lame or stiff in the hind legs, is uneasy, will not feed, &c. After this the fever commences, with shivering and trembling, with increased heat of the body; but the ears and tail particularly become very red; the nostrils and gums dry hot; the animal stands with drooping head, and the feet are close together under the belly; it is lame, or halts, particularly with the hind-legs; the ears hang, the eye is bloodshot; the fever increases, as also the difficulty of breathing; the animal feeds and ruminates little,

or not at all; its dry dung passes in very small, hard balls. Soon after the first attack of fever, there appear on all the bare parts of the body, particularly about the mouth, eyes, and on the inner surface of the leg and belly, and the under part of the tail, numerous small spots, like flea-bites, which in eight or nine days come more out in small pimples, and in form like the head of small-pox. As the spots become more numerous, the swelling of the head increases, so much so that the animal can but with difficulty open its mouth and eyes; the lumps that have formed fill, in three or four days, with a pale, clear, white matter. The pustules now formed are of a good sort, and differ in size up to that of a pea. They are found mostly on the parts of the body with no wool on, but they may be even found under the wool. The malignant pustules are found close together, of a red, violet, blue-blackish, or brown-red colour, with a blue margin; they are broad, flat, and sunk in, and emit an offensive smell. The animal stands unsteady, with drooping and swollen head, and closed eye; the nostrils are stopped up with a tough, viscous matter, smelling like carrion; it breathes very short and with difficulty, snorts with open mouth, gnashes its teeth, and its evacuations emit a very offensive odour; in this latter state, a cure is impossible. On the first attack of the common 'variola,' the animal must be well taken care of, and must not be exposed to cold or wet, and drinks must be administered to it of salts, bitters, and spices. As a preventative, inoculation with healthy matter, if obtainable, is the best, as thereby the inoculated animal throws out only a few of the pustules, the sickness from which it easily gets over, and is then completely protected from the attacks of the disease." Mr. Simonds, the lecturer on cattle pathology, in the Royal Veterinary College, also says that inoculation may be said to be our chief means of controlling the disease. Vaccination has been tried, but is not to be depended upon. The practical results are, that farmers should spare no pains to avoid buying infected sheep,—that they should invariably keep all newly bought animals separate from their own stock, until time shall have been afforded for the development of disease, if it exists,—and finally, that should the disease appear, not a moment should be lost in calling in the veterinary surgeon, and subjecting the whole flock to inoculation.

SMEARING. See Salving.

SMELL. See Nose.

SMILACINA. A genus of hardy, ornamental, perennial-rooted, herbaceous plants, of the smilax order. Nine species, varying in height from 3 to 25 inches, and carrying either white or yellow flowers in summer, have been introduced to Britain, principally from North America; and all love a soil of sandy loam or of somewhat humous loam, and are propagated by division of the root.

SMILAX. A genus of climbing, monocotyledonous, exotic plants, constituting the type of the natural order Smilaceæ. This order is very nearly allied to the asphodel family, differing from it principally in the trifid style and the membranous seed-envelopes. About a dozen hothouse species, about a score of greenhouse species, and about 80 hardy species at present occur in British collections, and are distributed among 12 genera. A considerable number are highly ornamental or otherwise popularly interesting; and a few are valuably medicinal.

Upwards of 40 species of the genus smilax have been introduced to Britain; and nearly 30 more are known. All or almost all are remarkable for the twining habit of their stems, and for the resemblance of their leaves to those of dicotyledonous plants. Some have prickly stems, and some unarmed stems; and some of both the prickly and the unarmed are angular, and others terete. Four of the most remarkable species are noticed in the article Sarsaparilla; and almost all the other species are interesting only to botanists.

SMITHIA. A small genus of interesting, exotic, annual plants, of the hedysarum division of the leguminous order. Three trailing, yellow-flowered, late-blooming species, the sensitive, the twin-flowered, and the crowded, have been introduced to Britain,—the last from Australia, and the other two from India.

SMUT. A disease of the ears of growing corn, filling the grain with a fine sooty-looking powder in the room of farina. It arises entirely from two minute coniomycetous fungi,—the *Uredo segetum* and the *Uredo fœtida;* but it attacks all sorts of corn, and presents a great diversity of appearance, and bears a number of different popular names, and has been erroneously ascribed, by all classes of cultivators, to a great diversity of causes. Some farmers, seeing only a very few ears of a crop perceptibly affected with smut, regard the evil as of small consequence, and are totally unaware that when no more than one smutted ear can be found in a sheaf, the straw of the apparently sound plants may want so much as one-third of its average weight, and the grain so much as three-sevenths; and other farmers, who may have a correct enough opinion of the mischievousness of smut, are so misled by false notions of its cause as either to reject all suitable preventives and remedies of it, or to adopt them empirically and without sufficient confidence and vigour.

Some of the many erroneous causes which have been assigned for smut have no connexion with it whatever; and others are mere contingencies which either aggravate its symptoms or accelerate its progress. One alleged cause is deficient fecundity, in consequence either of the pollen being washed away with rains, or of its undergoing some chemical change of a putrefactive nature; but smut is found to affect the organs of fructifi-

cation, and either to impair or to destroy them, long before the pollen can be formed. Another alleged cause, sanctioned long ago by the distinguished Jethro Tull, is humidity of the atmosphere, or the prevalence of fogs, or the bursting out of intense sunshine while the crop is in a moist condition; but this notion has been disproved by some carefully conducted appeals to experiment,—and is disproved also by the general fact, that smut is sometimes observable in an early stage of the plant's vegetation, long before it has escaped from the leafy envelopes. A third alleged cause is excessive moistness of the soil, —and certainly this, though not a cause, is a very powerful provocative, insomuch that well-drained and thoroughly aerated soils are incomparably freer from attacks of smut than wet ones; but the disease occurs on even the driest land, and may often be observed as rife in the dry parts of a field as in the wet parts. A fourth alleged cause, sanctioned by such high names as those of Somerville, Walker, and Linnæus, is the hatching and feeding of minute insects; but this opinion has been refuted by express and searching observation, and may be exploded also by the general fact that acari and aphides and other minute insects feed more or less on all sorts of plants, whether affected by smut or not, and almost always abound on decaying vegetable matter or on plants which are in a diseased or enfeebled condition. A fifth alleged cause is the abrasion of the seed-corn in the process of thrashing; but seeds thrashed in exactly the same way run to smut in some seasons and do not run to it in others,—and numerous grains of wheat of different sizes have been experimentally bruised with a hammer previous to sowing, and have not been found to produce smutted plants. A sixth cause, alleged by Wolfius, is monstrosity of the embryo; but male flowers, or male parts of flowers, as well as female ones, are liable to smut,—and they have no embryo. A seventh alleged cause is deficiency of nourishment, occasioned by poverty of soil or by crowdedness of crop; but diseases closely akin to smut attack the fructification of some perennial plants whose roots and stems, from year to year, are so vigorous as to indicate the presence of ample nutrition. An eighth alleged cause is fermentation within the ears of corn, occasioned by natural humidity, or by excessive slowness of development and deficiency of evaporation; but, if this were a true cause, it would account for the appearance of smut only after the seeds begin to be formed, and might be expected always to produce the disease in far greater extent than it is generally found to exist. Most other alleged causes either are akin to some of these eight, or are exceedingly fanciful, or confound smut with some other and widely different diseases; and they, therefore, need not be named.

The two species of fungi which produce smut, or whose spores constitute the fine, powdery, sooty-looking substance of the disease, possess a somewhat close resemblance to each other, and are usually described under one general name; yet, not only have they separate specific characters, but they make specifically different developments in corn-plants, and produce essentially different economical effects on crops; and they, therefore, require to be separately studied, and distinctively understood. The *Uredo segetum* has no smell, and is the species popularly called dust-brand, bunt-ear, and chimney-sweeper; and the *Uredo fœtida* has a disgusting smell, and is the species popularly called bunt, stinking-rust, bladder-brand, and pepper-brand;—or, according to a sort of discriminating popular nomenclature, the former is smut and the latter is smut-ball.

The *Uredo segetum* is much more minute than most other coniomycetous fungi which attack gramineous plants; and, in particular, is not half the size of *Uredo fœtida*. Its spores are so extremely small that not fewer than seven millions eight hundred and forty thousand would be required to cover one English square inch. It first so injures the interior portions of the flowers of the plants which it attacks as to render them abortive; it next makes the pedicels or little stalks of the florets swell and become very fleshy; it next consumes the whole of this fleshy mass; and it finally comes through the epidermis and appears between the chaff-scales in the form of a black soot-like powder, and looks as if adhering by means of some gummy substance to the young ear. It operates alike on wheat and barley and oats, and is essentially the same in them all; but it differs widely in aggregate coherence upon wheat and barley,—and differs also in the microscopic appearance of its spores,—but probably owes the differences entirely to the different action of the matrices in which it grows. It commonly attains maturity some weeks before the crop which it infests is ready for the sickle; and it then is a loose light powder resembling very fine lamp black, and is swept away and scattered by the winds,—so that, even when it has made great havoc upon a crop, it is seldom seen to any considerable extent at the time of harvest. It has sometimes been found to attack the leaves and the culms of corn plants; but, in general, it attacks only the ear,—and this it completely destroys. It is comparatively rare in wheat, and does not seem to occur at all in rye, but is very common in barley, and still more so in oats. It has also been observed in several of the forage grasses. Some farmers absurdly think that a little of it in the barley crop is a good sign; and most regard it as far less mischievous than *Uredo fœtida*. But, in so far as it exists, it is always and entirely a desolating evil; and it both escapes the observation of superficial observers, and eludes some of the common methods of preventing or extirpating it, by the early maturation and profuse dispersion of its spores; and though really

a less evil comparatively than *Uredo fœtida*, it is a much greater one absolutely than most farmers suppose.

Grain containing some mixture of smut has not been observed to injure fowls who eat it; and yet the straw of smutted plants is asserted to be distasteful to cattle. The effect of the fungus upon the wholesomeness of crops, in fact, is little understood, and does not seem to have been tested by any good published experiments; yet it may be pretty closely estimated by reference to the known chemical composition of smutted grain. "Chemical analysis has demonstrated that the *Uredo segetum* effects an entire decomposition of the vegetable constituents of the grain it infects, the saline constituents of the grain remaining nearly unaltered. Parmentier, Cornet, Girod Chantrans, Fourcroy, and Vauquelin, have successively examined it, and the result of their researches is, that smutted grains of wheat are composed, first, of about one-third their own weight of a green, butyraceous, fetid, and acrid oil,—second, nearly one-fourth of a vegeto-animal substance, perfectly similar to that which comes from putrid gluten,—third, a black coal, one-fifth of their weight, similar to that which is found in all remnants of putrified organic compounds,—fourth, free phosphoric acid, amounting scarcely to more than ·004 of the smut,—and fifth, phosphates of ammonia, magnesia, and lime, in the proportions of a few thousandths. 'We must remark,' say MM. Fourcroy and Vauquelin, 'that, in one examination of putrified gluten, we found characters very similar to those of the smut of wheat; and that the products of the one are so like those of the other, as to render it difficult, in certain cases, not to confound them together. It requires a man to be well practised in chemical experiments to discern the slight differences that exist between these two putrified matters, because the differences are only delicate shades, not easily discernible. The contagion attacks especially the gluten, and precedes, indeed prevents, the formation of the starch; since we know positively that this fecula, no traces of which are found in the smut of wheat, suffers no alteration from that septic process, which so powerfully attacks the glutinous substance.'"

The *Uredo fœtida* occurs only in the grain of wheat, and is a well known and much dreaded disease. It may be detected in the young seed, even in the very earliest states of the flower-bud; and when fully ripe, it most frequently occupies the whole interior of the grain. "The earliest period at which I discovered it within the cavity of the ovule of a young plant of wheat," says M. Bauer, "was sixteen days before the ear emerged from the hose, and about twenty days before the sound ears, springing from the same root, were in bloom. At that early stage, the inner cavity of the ovum is very small, and, after fecundation, is filled with the albumen or farinaceous substance of the seed, and already occupied by many young fungi, which from their jelly-like root or spawn, adhere to the membrane which lines the cavity, and from which they can be easily detached in small flakes, with that spawn. In that state, their very small pedicels may be distinctly seen. At first, the fungi are of a pure white colour; and when the ear emerges from its hose, the ovum is much enlarged, but still retains its original shape; and the fungi rapidly multiplying, many of them have then nearly come to maturity, assumed a darker colour, and, having separated from the spawn, lie loose in the cavity of the ovum. The infected grains continue growing, and the fungi continue to multiply till the sound grains have attained their full size and maturity, when the infected grains are easily distinguished from the sound ones, by their being generally larger and of a darker green colour; and if opened, they appear to be filled to excess with these dark-coloured fungi. But the grains infected with the *Uredo fœtida* very rarely burst, and these fungi are seldom found on the outside of the grain; but if a grain be bruised, they readily emit their offensive smell, which is worse than that from putrid fish. When the sound grains are perfectly ripe and dry, and assume their light brown colour, the infected grains also change, but to a somewhat darker brown, retaining, however, the same shape which the ovum had at its formation, the rudiments of the stigma also remaining unaltered." The spores which fill the grain constitute a fine, black, disgusting, fetid powder, and amount to about four millions in a single grain, and may be easily distinguished and examined through a microscope, and have then the appearance of articulated globules growing in a bundled manner upon threads; but the sporules which they contain, and which propagate the smut in the same general way in which seeds propagate phænogamous plants, are so surpassingly minute as to be scarcely distinguishable under very high powers of the microscope, appearing then only like a faint cloud or vapour in a puffy escape from the spores.

The *Uredo fœtida* not only destroys all the grains or plants which it directly attacks, but greatly deteriorates the value of the sound part of the general crop. The disgusting odour which it emits may be perceived on passing through a field where it prevails; and becomes cohesive to the fingers and intolerable to the sense when an infected ear or two are broken in the hand; and diffuses itself sufficiently through the sound grains by the contacts of growing and harvesting to render the flour made from them perceptibly malodorous and comparatively unfit for bread. Ready purchasers, however, are found among the manufacturers of gingerbread, who have discovered that the treacle, and whatever else they mix up with it, effectually disguise the odour of the fungus; and while such a mode

of employing the tainted flour would be perfectly unobjectionable if the odour were innoxious, it becomes censurable and wicked when good reason exists for suspecting the odour to be seriously unwholesome.

The sporules of both *Uredo segetum* and *Uredo fœtida* were long believed and have recently been proved to find their way into corn-plants by entering their spongioles with the moisture and ascending their interior with the sap. "There is little doubt," says Mr. George W. Johnson, "but that the mode in which smut is imparted to the plant is by its roots imbibing the extremely minute seeds of the fungus along with the moisture of the soil; and this opinion is confirmed by the observation that the disease is most prevalent when the winter has been mild, and the spring wet,—for in such seasons the abundant moisture passing through the soil is most likely to convey the seeds to the mouths of the plant's radical fibres." "That the sporules enter by the roots and circulate in the plant," says the Rev. Edwin Sidney, "has been the surmise of most observers; but no one has yet seen them grow; nor would this be the normal mode of growth. The spores themselves are undoubtedly too large to enter either by the stomata of the leaves, or the spongioles of the roots. Some ingenious experiments have been recently made by Mr. Berkeley, which he most kindly communicated to the author, that appear to establish the theory that these contents of the spores do enter the plant in the way suspected, and grow. The mode of proceeding was to immerse some seeds of wheat in water containing bunt. One of the first appearances was a curious mould with peculiar spores that sprung upon the spores of bunt. The plants which came up from these seeds were evidently affected; but no communication whatever could be traced between the cells of these plants and the shoots thrown out by the spores. No intrusion whatever of the mycelium developed by the bunt spores into the wheat could be discovered. This looks, therefore, as if the fine contents of the spores do certainly propagate the fungus." "Although the bunt-fungus confines its attacks to the young seed," says Professor Henslow, "it seems to be a condition essential to its propagation, that it should be introduced into the plant during the early stages of its growth, and that its sporules are most readily absorbed by the root during the germination of the seed from which the plant has sprung. It has been clearly proved that wheat plants may be easily infected, and the disease thus propagated, by simply rubbing the seeds before they are sown with the black powder, or spores, of the fungus. It is also as clearly ascertained that, if seeds thus tainted be thoroughly cleansed, the plants raised from them will not be infected; and this fact is now so well established, that the practice of washing or steeping seed-wheat in certain solutions almost universally prevails."

The following table, compiled from a paper in the Farmer's Journal for June 1828, shows the highly infectious nature of smut, and the good effects of pickling:—

I. Wheat merely put into the bag where smutted wheat had been.

Old wheat,	1 in 30	smutted
New Kentish red, kiln dried,	1 in 20	do.
Yellow Lammas, do.	1 in 3	do.
Spring wheat, having a small quantity of smut-powder shaken amongst it, more than	1 in 2	do.

II. Wheat when moistened rubbed with smut-powder.

Old red wheat,	1 in 7	smutted
New do.	1 in 6	do.
Do., kiln-dried,	1 in 8	do.
White wheat, do.	1 in 3	do.
Yellow Lammas, do.	1 in 7	do.
Spring wheat, do.	8 in 10	do.

III. Wheat when moistened rubbed with smut-powder, but afterwards, previous to sowing, washed in a solution of vitriol and chamber-lye.

Old wheat,	1 in 2,000 smutted
New wheat,	Clean.
Do., kiln-dried,	Clean.
White wheat, do.	Clean.
Yellow Lammas, do.	3 in 2,000 smutted

The chief preventive of smut in wheat is the steeping of the seed-corn in some suitable solution. The spores which, at the time of thrashing, are dispersed from smutted ears in the form of a fine powder, and which attach themselves to the sound grains, adhere with considerable obstinacy by means of an oily or greasy matter in their own substance, and cannot be thoroughly cleaned away except by means either of an alkali which shall combine with the oily matter and convert it into soap, or of some powerful substance which shall be adverse enough to vegetable life to kill the spores and yet not so adverse as to kill or injure the grains. The substances most commonly employed in alkaline steeps are lime, and salts of soda, potash, and ammonia; and those of a killing kind most commonly employed are arsenic, sulphate of copper, nitric acid, muriatic acid, and sulphuric acid. The use of poisons, however — particularly violent ones — is altogether unnecessary, and very dangerous, and not a little culpable; and the use even of excessively pungent substances, which are not strictly poisonous, is never so politic, and perhaps never so efficient, as that of the alkalies or of common salt or of some mixture of saline substances. The following table shows the results of extensive and accurate experiments, conducted by Mr. Bevan, in the growth upon a sandy soil at Leighton in Bedfordshire of specimens of wheat-seed steeped in a variety of liquids,—the columns A showing the results from sound grain, and the columns B showing those from smutted samples:—

LIQUIDS EMPLOYED.	Specific gravity of solution.	Number of smutted ears in three sheaves.		Bushels of good wheat per acre.		Cwts. of straw per acre.	
		A	B	A	B	A	B
Solution of potash,	1·357	1	81	21·6	13·6	36·6	29·1
muriate of potash,	1·097	3	218	20·2	10·1	36·0	21·1
nitrate of potash (saltpetre),	1·080	7	115	23·8	14·3	36·9	31·9
soda,	1·056	9	159	20·2	11·7	35·6	26·7
muriate of soda (common salt),	1·089	—	290	24·0	14·5	41·5	33·3
sulphate of soda (glauber salt),	1·047	12	241	21·6	12·3	38·5	27·8
muriate of ammonia (sal ammoniac),	1·026	1	150	19·8	17·6	35·4	30·2
common soot,	1·025	—	123	20·8	11·4	34·8	25·3
lime, saturated,	1·003	—	2	21·9	12·4	38·7	25·9
nitric acid (aquafortis),	1·016	The seed treated with this acid did not vegetate					
muriate acid (spirit of salt),	1·011	—	136	20·7	16·1	35·7	34·1
sulphuric acid (oil of vitriol),	1·050	—	—	20·4	17·8	35·4	37·1
Dry, in its natural state,	—	6	323	20·3	14·7	35·7	31·1
Washed in common water,	—	None sown.	107	—	18·3	—	35·8

"The experiments of Mr. Bevan," remarks Mr. George W. Johnson, "indicate that lime water is the most effective of these preparations; and if this be adopted, it may be prepared by mixing one pound of fresh lime with three gallons of boiling water, allowing these to stand for two hours, and the clear liquor then to be poured off, and immediately used. In this liquor the wheat should be soaked for twelve hours, stirred twice or thrice during the time, and then mixed, upon a floor, with the powder made by pouring three gallons of boiling water upon five pounds of lime. I have had no experience of the effects of lime-water as a preventive of the smut; but with stale urine and a solution of common salt, I have witnessed numerous and extensive experiments. The results, without exception, were favourable and nearly similar; and this being the case, a preference is to be given to common salt, as being decidedly the most cleanly and the least disgusting. The mode I have observed to be the most effective, is to wash the seed with pure water, pouring this off with all the floating grains, and then allowing the seed to soak for twelve hours in a solution of common salt, having a strength, or specific gravity, sufficient to float a common hen's egg." A solution of sulphate of soda, in co-operation with an application of lime, was found by M. de Dombasle, after many experiments, to be the most efficient steep. The solution requires about $17\frac{3}{4}$ lb. of the sulphate in 22 imperial gallons of water; and as this salt does not very readily dissolve, the solution ought to be commenced a day or so before it is wanted, and frequently stirred till all the salt is dissolved. "The grain is to be formed in heaps on a floor, which are to be completely moistened with the above wash by means of a watering pan with a rose head. During the time the wash is being poured over the heaps of grain, they must be kept constantly stirred about by means of wooden shovels, till the whole be perfectly moist, which is known by the wash running from the heaps after they are sufficiently saturated. After the grain is well moistened, lime in powder is to be immediately thrown over the heaps, in the proportion of nearly $4\frac{1}{2}$ lbs. to the 22 gallons, imperial, of grain; this is done gradually, while the grain is to be turned over in every direction, so that the whole may be intimately combined. When this is done, the grain may be either sown immediately, or kept for some days, in which case it may be turned over every three or four days."

The use of any kind of steep, however, is a preventive of smut only as propagated by the adhesion of spores to the grains of the seed-corn, and can have no efficiency whatever against the germination of spores which lie lodged in the soil independently of the seed-corn. "Although it is very apparent," says Mr. George W. Johnson, "that the smut is generally imparted to a wheat crop by the agency of the seed sown, yet I am by no means of opinion that this is the only source of infection. I have kept ears of wheat that were covered and destroyed by the *Uredo*, during more than twelve months, in a situation where they experienced the vicissitudes of temperature during all the seasons, unprotected by more than the paper envelope in which they were suspended in an outhouse. Yet when the *Uredo* that had been thus exposed was mixed with healthy, well-washed seed-wheat, this produced diseased plants in a triplicate proportion more numerous than that not so mixed. This experiment demonstrates that frost and drought, acting in concert with a damp atmosphere, do not destroy the vegetating power of the *Uredo's* seed. Such being the fact, why may not this seed remain in the soil ready to impart the plague? We know that, owing to its extreme lightness, this seed floats buoyantly in the air, and may be carried by winds to distant soils, which, in the autumn of the same year, before any extremity of cold has been endured, will have to bear the wheat crop for the following harvest. The opinion that the soil is one source of infection, is sustained by the fact that fields in the vicinity of the sea are rarely injured, and never extensively, by the ravages of the smut. Such soils are impregnated more than any other with common salt, and the effect of this saline compound upon the *Uredo* has been noticed already." The spores of *Uredo segetum*, too, are so generally shed and dispersed before the har-

vesting of the crop, that they may be supposed to lie lodged in immense numbers in every part of the field or farm or district where they were produced; and even in so far as they adhere to the grains of barley and oats in the same way in which those of *Uredo fœtida* adhere to the grains of wheat, they have such a peculiarly strong hold in connexion with the integuments of these grains that they cannot very readily be reduced or killed by means of steeps. As regards some smutted wheat lands, therefore, and especially as regards all smutted barley lands and all smutted oat lands, other preventives and remedies must be brought into requisition, and should be such as to secure the utmost possible cleanness of both the seed-corn and the land, and will, after all, be found incompetent to effect an entire cure. "Since the smut-fungus does not confine its attacks to corn, but is also found in the grasses which grow in pastures and by the road-side," says Professor Henslow, "a plentiful supply of sporules will always be kept up, to warrant our believing that we shall never expunge this species from the British Flora. Still we may feel assured that precautionary measures may materially lessen an evil which cannot be wholly avoided. Since the sporules of the two fungi which produce bunt and smut enter the plants they attack by absorption at the roots, and since they are buried with those seeds to whose surface they have attached themselves,—it is evident that too great care cannot be bestowed in procuring clean seed, or in purifying such as may accidentally be infected. From a variety of considerations, it has always appeared to me strange that practical agriculturists are accustomed to pay so little attention to the raising of pure seed-crops. There may be reasons, which I do not properly appreciate, that would render it inexpedient to cultivate a seed-crop apart from the rest of the produce raised on a farm; but I should have thought that it was always worth while for every farmer to set aside some portion of ground to be more carefully tended than the rest, for the purpose of securing good and perfectly clean seed. Among other reasons for such a practice, he would then be able to weed his crop from every plant infected with bunt or smut, before the fungi ripened." The obtaining of seed-corn for any farm from other and distant soils is recommended by Tull, Donat, Lignerolle, and others; but, however beneficial this may be for securing other desirable effects, it can be useful in regard to smut only when the seed-corn is brought from a district remarkably free from that disease. All the preventives and remedies which address themselves to the state of the land, or consist in special processes of georgy and special methods of culture, are the same in the case of smut as in the case of mildew. See the article Mildew.

SMYRNIUM,—popularly *Alexanders*. A genus of herbaceous plants, of the umbelliferous order. The common species, *Smyrnium olusatrum*, grows wild on the rocks by the sea-shore in many parts of Britain, and has a place in gardens as a culinary plant. Its root is biennial; its stem is furrowed, branched, and 3 or 4 feet high; its lower leaves resemble those of smallage, but are much larger, and have rounder and serrated lobes; its upper leaves are trifoliate, and similar in form to the lower, but smaller; its flowers grow in large umbels at the ends of the branches, and bloom in May and June; and its capsules are large and roundish, and contain each two moon-shaped seeds. The whole plant has a strong warm taste; and its blanched stems are used in salads and soups. Crops are raised from seeds sown in spring in drills; and the plants may either remain or be transplanted into shallow drills at distances of 15 or 18 inches from drill to drill and of 5 or 6 from plant to plant, and must be earthed up in the same manner as celery.—Five or six ornamental species, all hardy and either biennials or perennials, and varying in height from 12 to 40 inches, and mostly carrying flowers of either yellowish or whitish colours, have been introduced to Britain from Caucasus, Continental Europe, and North America.

SNAG. The stump of a stem or lower part of a branch left in very free pruning.

SNAIL. See Slug.

SNAIL-COD. A soft, silty deposit on the bottom of deep rivers, abounding in molluscs and shells, and serviceable as manure. See the article Sea-Ooze.

SNAIL-FLOWER. The caracalla kidney-bean. See the article Kidney-Bean.

SNAKE. A tribe of ophidious reptiles. It comprises all serpents, whether venomous or non-venomous, whose sub-caudal plates are arranged in pairs; and even exclusive of all venomous species, it is so enormously numerous as to have put the ingenuity and inventiveness of naturalists severely to the test to subdivide and classify it. Eleven genera of non-venomous snakes are enumerated by Cuvier. The common snake, *Coluber natrix*, is a native of Britain, and occurs in bushy places and in banks near water. It is from two to three feet long. Its back has a dusky colour; and its belly is beautifully variegated with black and bluish stripes. It has two rows of small serrated teeth; but has no fang, and is perfectly harmless. It feeds on insects, frogs, field mice, harvest mice, and vegetable substances; and ought to be regarded as friendly to the farmer by destroying some of the pests of the field. See the article Reptiles.

SNAKE-GOURD,—botanically *Trichosanthes*. A genus of exotic, trailing, annual plants, of the cucumber order. Five or six white-flowered species have been introduced to British collections from India and China; but they do not possess any particular interest.

SNAKE-ROOT,—botanically *Ophiorhiza*. A tropical, ornamental, white-flowered, evergreen shrub of the madder family. It was introduced

to British hothouses about 28 years ago from India; and it has a height of about 3 feet, and blooms from the beginning of summer till the middle of winter. It constitutes a genus of itself. The name snake-root is borne also by a plant of the birthwort genus. See the article ARISTOLOCHIA.

SNAKE'S-BEARD,—botanically *Ophiopogon*. A small genus of curious, half-tender, evergreen herbs, of the smilax family. Two species, of respectively about 12 and 20 inches high, have been introduced to Britain from China and Japan.

SNAKE'S-HEAD. See FRITILLARY.

SNAKE'S-TONGUE,—botanically *Lygodium*. A genus of exotic ornamental ferns, of the gleichenia tribe. Seven or eight species have been introduced to the hothouses of Britain from the Indies and Continental America; and nearly twenty more are known. Most of the introduced species are flexible twiners or climbers of about 6 feet in height, and possess a high degree of elegance.

SNAKEWEED. See BISTORT.

SNAKEWOOD. A small genus of ornamental, tropical, evergreen trees, of from 20 to 35 feet in height, of the nettle family,—*Cecropia;* also, a Bahamese, evergreen, timber-tree, of about 20 or 25 feet in height, of the redwood genus,—*Ceanothus colubrinus*.

SNAPDRAGON,—botanically *Antirrhinum*. A genus of ornamental herbaceous plants, of the figwort family. Two species grow wild in Britain; eight or nine have been introduced from Continental Europe and California; a few more are known; and very many, which formerly ranked as snapdragons, are now included in the genera linaria and nemesia. One of the indigenous and two of the introduced species are annuals of from a foot to two feet in height, with respectively carmine, red, and variegated flowers; two of the introduced species are small, evergreen, half-tender trailers with white flowers; the other introduced species are hardy erect evergreens, chiefly with pink flowers; and the other indigenous species is a hardy erect evergreen, comprising varieties with respectively pink, scarlet, carmine, scarlet and white, and variegated flowers, and also one with variegated leaves. But the different colours of the flowers are variable in seedlings; and many most splendidly tinted and brilliantly variegated ones are borne by permanent hybrids. Choice old varieties are propagated from cuttings; and both the normal plants and new varieties are raised from seeds. All the good kinds are very showy; and many of them rank among the most conspicuous and admired beauties of the parterres of cottages and villas, and of the open borders of large flower-gardens. The perennial sorts flourish best and endure longest upon old walls,—and succeed not amiss upon poor, dry, sandy or gravelly soils; but generally die out in two years, or rot away in the second autumn or winter, on any common garden soil. All the common kinds should be raised from sowings in the early part of March on walls, rocky barren spots, or patches of very poor dry soil, and allowed to remain permanently where they grow; and they will require very little culture, and will continue long in bloom every year, and may be made to render some abject parts of a garden very agreeable.

SNEEZEWORT. See MILFOIL.

SNIFFLES. A disease of rabbits. It proclaims itself by constant sneezing, and by a profuse discharge of mucus from the nose; and, after continuing for a few weeks without seeming to grow worse, it suddenly terminates in pining and death. It arises from confined damp air, and is exceedingly infectious. Whenever it appears in a set of hutches, the affected animals should be killed, the hutches washed with chloride of lime, a better ventilation established, and a fresh stock of rabbits provided.

SNIPE. A group of birds, of the long-billed family of the wading order. It is sometimes understood so extensively as to comprise several genera of the longirostres; sometimes coextensively with the reduced genus scolopax; and sometimes so limitedly as to comprise only the three species popularly called the common snipe, the great snipe, and the Jack snipe. The characters of the reduced genus scolopax—shared by these three species with the woodcock, the red-breasted snipe, and some others—are straight bill, with the point a little inflated externally, and the nasal furrows extending nearly to the point,—compressed head, large eyes placed very far back, and non-palmated feet.

The common snipe, *Scolopax gallinago*, weighs four ounces, and is nearly twelve inches long and about fourteen broad. The bill is three inches long, flat at the end, often rough, and either pale brown or greenish yellow; the head is marked lengthwise by two broad black bands; the chin is white; the neck is variegated with brown and red and fawn; the scapulars are striped on one web beautifully lengthwise, and barred on the other with black and yellow; the quill feathers are dusky, and those next the back are barred with black and pale red; the breast and the belly are white; and the tail coverts are reddish brown, and long, and almost cover the tail. This bird frequents marshes, edges of rivulets, and similar situations in almost all parts of the world; and it ascends out of sight, and utters from a great distance its piercing note, which sounds like the bleating of a goat. In winter, the snipes of Britain are common inhabitants of our marshes and rank meadows, and shelter themselves there among the rushes and other coarse aquatic vegetation. In summer, they disperse to different parts, and are found in the midst of our highest mountains, as well as in our low moors. They begin to pipe in the first week of April. Many of them breed with us; and their nest is composed of dried grass and herbs,

with sometimes a few feathers. They lay four or five eggs, of a dirty olive colour, marked with dusky spots. The young appear ugly and shapeless; and the mother never deserts them until their long bill is firm enough to enable them to procure their food. The cock, while the hen is sitting, poises himself on his wings, sometimes making a whistling, and frequently a drumming, noise; and it is uncertain whether this noise is ventriloquous, or is produced by the motion of the wings. Mr. White says, it happens always when the bird is descending, and his wings are violently agitated. Snipes feed on worms and insects which they find in the moist ground, and also on small snails, which they sometimes swallow whole. They usually have abundance of fat, which is not apt to cloy, and rarely disagrees with those that eat it; and they are cooked like the woodcock, without extracting the entrails, and are every where esteemed for their delicious flavour.

The great snipe, *Scolopax major*, is distinguished from the common snipe by being about one-third larger, and by its fawn-coloured variegations above being smaller, and the brown ones below larger and more numerous. It is comparatively rare in England, and occurs always alone and detached, and is sometimes called the solitary snipe. Some persons have supposed it to be not a distinct species, but merely an old and overgrown common snipe, changed in its plumage from age, and enlarged in its bulk from ceasing to breed.

The Jack snipe or Judcock, *Scolopax gallinula*, is nearly one-half smaller than the common snipe, and has but one black band on the head. Its neck is variegated with white, brown, and pale red; its scapulars are narrow, very long, brown, and margined with yellow; its tail is brown, and has tawny edges; and its legs are cinereous green. It frequents the same haunts and feeds on the same fare as the common snipe; but it is more rare, and lies so close as to incur the risk of being trodden on before it will rise, so that it is very difficult to be found. It never flies far, and has a comparatively sluggish motion.

SNOW. Frozen vapour deposited in powdery globules or in flaky and spicular crystals from the atmosphere. It has the same relation to rain which hoar-frost has to dew or which ice has to water. It is supposed to be formed at no great height in the atmosphere, and while the vapour is collapsing into drops. The powdery varieties, in particular, are believed to be formed near the surface of the earth; and they have a greater density than the flaky varieties, and fall more rapidly, and enclose a much smaller volume of gases within their cells and interstices, and possess much less power to act usefully upon the soil and upon vegetation. The flaky and spicular varieties are very numerous, and, in most instances, have very beautiful crystalline forms. Some are lamellar stelliform crystals; some, lamellar regular hexagons; some, lamellar aggregations of hexagons; some, lamellar hexagons with projecting radii or salient angles; some, spheres or central lamellar plates with spinous processes; some, six-sided prisms; some, hexagonal pyramids; and some, spiculæ with one or both extremities fixed to the centre of a lamellar plate. The six-sided prisms are hard and firm and small, and appear to be formed at much higher elevations than the other kinds; they constitute the chief bulk of the snow of very lofty alpine regions, and are there lifted and whirled and tossed by the winds in a similar manner to the light sands of an arid desert; and they are commonly accompanied in Britain with some of the lamellar varieties, which are believed to intercept them and mix with them in the lower part of their descent. The wheeled and stellate and spinose and compoundly hexagonal varieties constitute the largest flakes and the softest snowy masses, and fall in calm weather, in low districts, and with a slow and sluggish motion. Flakes which are nine times less dense, or nine times more expanded then water, fall, on the average, three times less slowly; and the largest flakes are commonly formed in a frost so mild as to make the crystals soft and humid, and to allow them to cohere somewhat in the manner of the rays of feathers. All flaky snow, as soon as it has fallen, begins to consolidate into increasingly denser conditions; and it owes both this power of self-condensation and the capacity of great cohesion under mechanical pressure to the acicular texture of its crystals, and to the presence of a certain degree of enclosed and coherent moisture which afterwards freezes. Sheets of snow on the ground are well known to reflect beautiful pink and blue tints under certain angles of sunshine, and to fling back so much light as to be painful to the eyes by day and to guide the traveller in the absence of moonshine at night. Snow, especially when newly fallen, contains a comparatively large impregnation of carbonic acid, ammonia, and other atmospheric gases; and yet, when caught in falling, or when lifted without permitting any possibility of contamination from the soil or from smokes or exhalations, it yields as pure water as mountain rain, —the purest which can be obtained from natural sources.

Snow is an exceedingly reluctant conductor of heat; and, when forming a layer of two or three inches, or even less, upon the soil, it prevents the internal heat of the earth from radiating into the atmosphere, and preserves the surface of the land from congelation by subsequent frost; and it therefore ameliorates the soil in winter, protects the life of the natural grasses and herbage plants during the long and rigorous frosts of high latitudes, shelters the cereal grasses and other field-plants of Britain so as to keep them safe in winter and make them rise vigorously in

spring, and occasions a continual flow of water in the form of perennial springs from beneath the perpetually frozen summits and shoulders of alpine mountains.

The sowing of the seeds of many kinds of greenhouse plants in snow, such as those of the heath, the rhodora, the cactus, the leguminous, and the gourd orders, has been found, in somewhat recent experiments on the Continent, to promote germination. The manner of sowing is to fill the pots to a suitable height with the kind of soil proper for each species, to put a layer of snow on the top of the soil, to sow the seed on this, to put another layer of snow over the seed, to set the pots thus sown in a glass-covered box, to place the box in a house at a temperature of about 59° or 60° Fahrenheit, and, as soon as the snow melts or the germ appears, according to the nature of the species, to lay on a sprinkling of sandy earth. The germination is said to be both surer and more rapid than in the ordinary methods of sowing. "It appears to me," says Liebig, "that the loose formation of the snow, which allows of an uninterrupted admission of oxygen, the exclusion of those foreign agents which are always found in a soil that contains corrupted vegetable matter, and finally, the volatile alkali of the snow—all these causes combined effect the remarkable appearance of germination in this process." Another physiologist takes a similar view of the matter, and suggests the two following additional explanations:—"1. When the seed is in the snow, the temperature cannot be far from the freezing point, as long as there is snow there; the melted snow, provided it is not warm, does not draw any matter from the seed which is necessary for its vitality, therefore, it remains the same. 2. The melted snow only moistens the surface of the seed, without submerging it, and easily penetrates the cells of the seeds by means of the capillary tubes, from which the air must escape; if the seed is too moist, the excess of fluidity does not produce a proportionate softness of the seed, as the air that is contained in the seed cannot so easily escape to give place to the moisture."

SNOWBALL-TREE. See GUELDER ROSE.

SNOWBERRY, — botanically *Chiococca*. A small genus of exotic plants of the madder family. The racemose species, *C. racemosa*, is a white-flowered, ornamental, evergreen, winter-blooming shrub, of about 6 feet in height, and was introduced to the hothouse collections of Britain, upwards of a century ago, from Jamaica. —The serpent-expelling species, *C. anguifuga*, is a white-flowered, medicinal, evergreen, summer-blooming shrub, of about 3 feet in height; and was introduced to Britain about 24 years ago from Brazil.

SNOWDROP, — botanically *Galanthus*. A small genus of hardy, ornamental, bulbous-rooted plants, of the amaryllis order. The common species, *G. nivalis*, grows wild in the meadows, orchards, hedge-sides, and river-banks of many parts of Britain; and is a great and universal favourite as a winter-blooming or early spring-blooming ornament of all sorts of open-ground flower gardens. It comprises three varieties,—the single, the semi-double, and the double. Its bulb resembles that of a narcissus, but is much smaller; its leaves rise from the crown of the bulb, and are erect, obtuse, keeled, and glaucous; its flower-stalk ascends from the midst of the leaves, and is slender, drooping, and about 4 or 6 inches high; and its flower is solitary, white, scentless, and beautiful. This plant thrives in almost any soil, and multiplies exceedingly by bulbous offsets, and requires scarcely any culture; and though inconspicuous and paltry when planted singly, it makes a fine appearance, and contrasts most sumptuously with the general wintriness of the garden, when planted in close groups of twenty bulbs or upwards in each group. It prospers well under trees or hedges; and is therefore suitable for wood-walks and wilderness quarters. The bulbs may be taken up in the latter part of June, when the leaves decay, and may be kept out of the ground till the end of August; but they must not be removed oftener than every third year.—The plaited snowdrop, *G. plicatus*, was introduced to Britain about 30 years ago from the Crimea; and is similar in height and habit and general appearance to the common species.

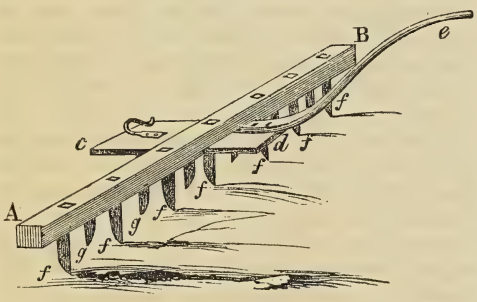
SNOWDROP-TREE,—botanically *Halesia*. A small genus of hardy, ornamental, white-flowered, deciduous, North American shrubs, of the storax family. Three species, the two-winged, the small-flowered, and the four-winged, respectively about 6, 8, and 10 feet high, have been introduced to the shrubberies of Britain; and all bloom in the advanced part of spring, and love a soil of peaty loam, and are propagated from layers.—The name snowdrop-tree is sometimes given also to the chionanthus genus. See the article FRINGE-TREE.

SNOWFLAKE, — botanically *Leucojum*. A genus of hardy, ornamental, bulbous-rooted plants, of the amaryllis order. The summer species, *L. æstivum*, grows wild in the moist meadows and marshy river banks of some parts of England, and has a height of from 15 to 20 inches, and blooms in April and May; and the spring species, *L. vernum*, was introduced to Britain from Germany toward the close of the 16th century, and has a height of about 8 or 10 inches, and blooms from January till March,—but comprises a later blooming variety from the Carpathian Mountains, and an abundantly flowering variety which originated in gardens; and both species have white flowers very similar to those of the snowdrop, and were formerly known among florists under the name of tall snowdrops, —and they love a soil of sandy loam, and are propagated, in the same sort of way as daffodils and narcissi, from bulbous offsets.

SNOW-HARROW AND SNOW-PLOUGH. Implements for making such tracts through snow on sheep pastures as will facilitate the melting of the snow, and enable sheep to move about with ease in search of their food. They are often of great use in upland districts, both during protracted snow-storms in winter, and after falls of snow subsequent to the commencement of the lambing season. A snow-harrow and a mountain snow-plough which were constructed by J. Stewart Hepburn, Esq. of Colquhalzie, and which were honoured with the Highland Society's silver medal, and are described in their Transactions, seem to be perfectly efficient, and at the same time possess the recommendation of comparative simplicity.

"The snow-harrow," says Mr. Hepburn, "consists of a bar or head A B, Fig. 1, 4½ inches square, and 6 feet long, in the middle of which, on the under side, a piece of 1¼-inch plank *c d*, 3 feet long, is sunk flush transversely, for the

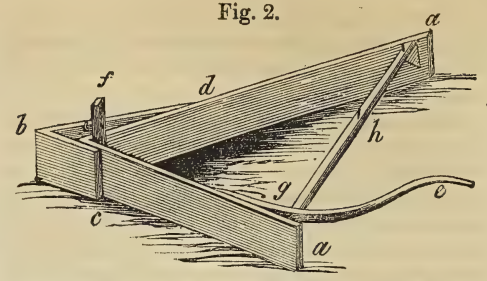
Fig. 1.



attachment of the draught-hook, *c*, and the stilt, *e*, and to steady the motion of the implement. In this head are fixed, by screw-nuts, at intervals of 10 inches, 7 cutters *f f*, &c., 9 inches long, and 1⅜ broad, sabre-shaped, with their points turned backwards, so as to be less readily arrested by obstacles on the surface of the ground. Between these are fixed 6 short cutters *g g*, &c., 3 inches long, having their points turned forwards. This implement dragged by one horse, rode by a boy, and the stilt held by a man behind, cuts the frozen snow into stripes 5 or 6 inches broad, which are easily pulverized by the feet of the sheep, or divided by the snow-plough."

"The severity of the winter of 1837-8 in mountain sheep-pastures," continues Mr. Hepburn, "led me to attempt to adapt the snow-plough, with or without the aid of the snow-harrow, for being applied in such situations. To enable the plough to clear tracks for the sheep along the steep hill-sides, it is necessary it should be made to throw the snow wholly to the lower side. To effect this, I caused to be fitted to the plough, *a a*, Fig. 2—the body of which forms an isosceles triangle, whose sides are 7½ feet, and its base 6 feet in length, the depth of the sides being 15 inches—a shifting head, *b c d*, with unequal sides; one, *b c*, being 18 inches; the other, *b d*, 30 inches long, fixed by iron pins

Fig. 2.



passing through 2 pairs of eyes, as seen at *c*, attached to the head and to the sides of the plough respectively, so as to bring the point of the attached head of the plough nearly into the line of its upper side, or that next the hill. The stilt, *e*, at the same time, was made moveable by a hinge-joint at its anterior extremity, fixed to the bottom of the head frame-post *f*, so as to be capable of being fixed to the cross-bar or stretcher, *g a*, either in the line bisecting the angle, as at *h* (which is the position for level ground), or in the line, alternately, of either of the sides, *b a* or *b g*, when to be used on a declivity. The draught-chain is fixed, not to the shifting head, but to the upright frame-post *f*, in the nose of the plough which rises 10 or 12 inches above the mould-boards. When the plough, so constructed, is to be worked along a declivity, with the left hand towards the hill, the shorter limb of the shifting head is fixed on the left side of the plough, near the point; and the longer limb, on the right side, towards the middle; and, the stilt being fixed on the left extremity of the cross-bar, nearly in a line with the temporary point, the plough is necessarily drawn in the direction of its left side, so as to throw the snow wholly to the right down the hill. When the plough is to return across the declivity with its right side to the hill, the moveable head is detached by drawing out the linch pins, is turned upside down, and fixed in a reverse position; the shorter limb being attached to the right side, and the longer to the left side of the plough, while the stilt is brought to the right extremity, *a*, of the cross-bar. The plough is then drawn in the direction of the right side, and the snow is thrown wholly to the left, now the lower side. Should the lower side of the plough show a tendency to rise, it may either be held down by a second moveable stilt, fixed to the middle, *h*, of the cross-bar, or a block of wood, or other ballast weight, may be placed on that side of the plough."

SNOW-THISTLE. See ANDRYALA.

SOAP. A compound resulting from the combination of an oil or a fat with an alkali or an alkaline earth. See the article OIL. It was invented by the Gauls at a period prior to historical record; and has long been a common article of manufacture, in many ways, of many varieties, in many lands. It is usually made of the cheapest fats and crudest alkalies in rude countries,—of animal fats and coarse alkalies, with various admixtures,

in Britain, — and of vegetable oils and refined alkalies, with sometimes modifying substances, in some parts of the south of Europe. Hard soap owes its distinctive characters to soda; soft soap, to potash; white soap, to comparatively pure tallow; yellow or brown soap, to a mixture of tallow and resin; and mottled soap, to the dispersion of ley throughout it in the last stage of its manufacture, or to the admixture of sulphate of iron, oxide of manganese, and other colouring substances. The desirable properties and the detergent uses of all common soaps are so universally known as not to require any remark. Well-made, hard soap, fit for internal administration as a medicine, should be made of olive oil or almond oil and soda; and is generally imported from Spain and Italy and the South of France; and has a white colour, a firm consistence, a marble-like surface, an alkalescent taste, and very little odour,—makes an opaque milky solution with water,—and is decomposed by all the acids, by acidulous salts, by all the earths, and by most of the metallic salts. It is used, in human pharmacy, as a lithontriptic, a mild aperient, a diuretic, and an antidote to metallic poisons; and in veterinary pharmacy, as a diuretic, and sometimes, though quite improperly, as an ingredient in physic balls. Soap of various kinds and in various ways is also used externally as a remedy for tumefactions, sprains, and bruises.

SOAPBERRY,—botanically *Sapindus*. A genus of ornamental, tropical, thalamiflorous, evergreen, ligneous plants, constituting the type of the natural order Sapindaceæ. The petals of this order have either an additional lobe inside or a tuft of hairs instead; the flowers of most are white and grow in bunches; and the leaves of nearly all are compound. A few of the species are twining herbs; but most are shrubs or trees; and nearly all are natives of the tropical or subtropical regions of the old world. The entire fruit of a few is deliciously esculent; and parts of the fruit of one or two others is also excellent eating. One hardy species, nearly twenty greenhouse species, and about eighty hothouse species have been introduced to Britain, and are distributed among three tribes and about twenty genera.

The soapberry genus comprises about a dozen of the introduced species, and nearly as many more known unintroduced species. All the introduced species are hothouse, evergreen small trees or tall shrubs, varying in natural height from 10 to 30 feet, carrying either white or herbaceous-coloured flowers, and, with some exceptions, loving a soil of peaty loam and propagable from cuttings.—The common species, *Sapindus saponaria*, was introduced about 250 years ago, and is a native of the West Indies. Its stem naturally attains a height of from 20 to 30 feet, and sends out many branches toward the top; its leaves are pinnate, and comprise each a midrib with a leafy border and from three to five pairs of leaflets; its leaflets are pale green, pretty stiff, from 3 to 4 inches long, pointed at both ends, and about 1¼ inch broad in the middle; its flowers come out in loose spikes at the ends of the branches, and are small, white, and inconspicuous; and its fruit are oval berries, about as large as middle-sized cherries, growing singly or in twos or threes or fours, each comprising a saponaceous skin and an enclosed, hard nut. The skin of the fruit is used in America for washing linen, but, when employed often, is very apt to burn and destroy it; and the nuts are very smooth and of a shining black colour, and were formerly imported to England, and manufactured into buttons, which were sometimes tipped with silver, and always very durable.—The emarginated soapberry, *Sapindus emarginatus*, was introduced about 26 years ago, and is a native of India. It has naturally a height of about 15 feet. The skin of its fruit is used by the Hindoos for the same purposes as soap, and prescribed by their physicians as a remedy for humoral asthma.—The rusty soapberry, *Sapindus rubiginosus*, is also a native of India, and has naturally a height of about 15 or 20 feet; and its timber is straight, strong, and durable, and is found very useful for a great variety of purposes.

SOAPER'S WASTE. The refuse of soap manufactories. It varies in composition according to the kind of soap from which it comes, and the qualities and condition of the alkali employed; but, in all its varieties, it acts as a powerful fertilizer. One specimen or coarse kind of it is stated, in a crudely reported analysis, to comprise 57 per cent. of mild calx, 11 of magnesia, 6 of argil, and 21 of silex; but such a kind as this, which comes from soap made with lime and the crude varieties of kelp and barilla, is less valuable than kinds from soap made with good kelp and barilla; and these latter, again, are less valuable than kinds from good or best common white soaps. "Soaper's waste," says Donaldson, "has been applied on almost every description of soil, and generally with good success. On cold wet soils, on sour meadows, and on moss, the effects have been great with 60 bushels to an acre; while in some instances, the quantity applied to an acre has been as much as 40 tons, and the average allowance may be stated at 150 bushels. The hot caustic quality will be harmless on wet strong soils; on all light lands, the safer mode of application will be by mixing the soap with four times the bulk of good earth, which will make a fine compost for grass-lands and young crops. The caustic quality of such substances requires correction, which is well accomplished by exposure, and by mixing with cool materials in a greater quantity. Great results have been published as having been derived from using soaper's waste; and in experiments with other manures the unmixed substance seems to have yielded most produce, while in another instance an application to wheat showed no per-

ceptible difference. A waggon load is said to be equal to five loads of rotten dung, and more confidently that one load of soap waste, with 5 of dung, would be more valuable than 10 of dung, both in effect and in duration. The first substance will cover less ground at the same rate of application, and if laid on the same extent of space, one would think that the superior or equal quality has much to contend against,—in one case, more extent of ground,—and in the latter, the effects of nearly twice the quantity of the substance of which it is chiefly composed."

SOAPWORT,—botanically *Saponaria*. A genus of ornamental herbaceous plants of the carnation family. The officinal species, *S. officinalis*, grows wild in meadows, under hedges, on river banks, and in similar situations in many parts of England. Its root is perennial, creeping, spreading, ramose, and rather fleshy, and soon occupies a large space of ground; its stems are jointed, erect, cylindrical, purplish, leafy, and about 18 inches high; its leaves are opposite, ovate-lanceolate, smooth, pale green, and about 3 inches long and $1\frac{1}{2}$ inch broad; its flowers come out in dense panicles from the wings of the leaves, and are large, handsome, and of a flesh or pale pink colour, and emit an oppressively sweet odour, and bloom from July till October; and its capsules are oval and one-celled, and are filled with many small seeds. A decoction of this plant has been used in some countries as a substitute for soap, and is well capable of cleansing woollen fabrics; and the leaves were formerly used in medicine, and are accounted opening, attenuating, and somewhat sudorific. A variety with double flowers, *S. o. plena*, has long been known in the flower-garden; but it spreads so rapidly and far, that it ought not to have a place among better flowering-plants.—Four or five perennial-rooted species, one biennial, and seven or eight annuals, have been introduced to Britain, principally from Continental Europe and the Levant; and all are hardy, most have either pink or red flowers, some are truly beautiful, and well worthy of a place in the flower border, and the majority love a soil of sandy peat, but will thrive in all common light garden soils. The basil-like species, *S. ocymoides*,—a native of France, a low evergreen trailer, with handsome red flowers, blooming from May till July—is well adapted for rock-work.

SODA. The protoxide of sodium. It is obtainable in large quantities from sea-water, and occurs profusely, though somewhat mixedly or impurely, as an efflorescence on the marshes and lake-banks of some hot countries, and is an important ingredient in soils, and can be manufactured from some large deposits of the saliferous sandstone formation,—and, for all these reasons, as well as for the sake of distinction from potash and ammonia, it has been not inappropriately called the mineral alkali; but it is also an important constituent of many plants,—and, in point of fact, was long obtained for commercial and manufacturing and economical and medicinal purposes mainly through the medium of kelp, from marine algæ, and through the medium of barilla from the plant called *Salsola soda* and from other plants of the goosefoot order. See the articles Kelp, Barilla, Alkalies, Ashes, Salts, and Goosefoot; and see also the articles Nitrates, Natron, and Salt (Common).

Sodium is an elementary substance of a metallic nature; and was discovered in 1807 by Sir Humphrey Davy. It does not naturally occur in a simple state; but may easily be obtained from its natural compounds by means of galvanism, or by similar processes to those used for obtaining potassium from the salts of potash. It has a colour similar to that of silver, and a strong metallic lustre, and a specific gravity of 0·972; it is compressible by the fingers at common temperatures, and melts at 200° Fahrenheit, and rises into vapour at a red heat; and when thrown upon water, it causes a violent effervescence, emits a hissing noise, and rapidly combines with oxygen so as to form soda. The peroxide of sodium, consisting of two equivalents of sodium and three of oxygen, may be artificially formed by heating sodium to redness in excess of pure oxygen; but it is of small economical importance, and is resolvable by water into soda and oxygen.

Soda, or protoxide of sodium, is obtained in purity by burning sodium in dry atmospheric air. It consists of one equivalent of sodium and one equivalent of oxygen; and is a grey white solid, difficult of fusion. It forms with water, equivalent to equivalent, a solid hydrate; and this is soluble in water and alcohol, easily fusible by heat, very caustic, and exceedingly analogous in all its chemical relations to potash. All the salts of soda are soluble in water, and are incapable of being precipitated thence by any reagent; all, on being exposed by means of platinum wire to the blow-pipe flame, communicate to it a rich yellow colour; and soda itself combines with sulphuric acid to form a salt which is easily recognised by its taste and form to be Glauber's salt; and by these three characters is soda chemically and readily distinguishable from other alkaline bases.

The common uses of soda are mentioned in the articles Kelp and Barilla; and two of the most important salts of it are noticed in the articles Glauber's Salt and Nitrates.—The carbonate of soda is prepared by a purifying process from barilla; and forms into large, transparent, octahedronal crystals with a rhombic base; and has a mild alkalescent taste; and is used in medicine as an antacid and a deobstruent. Its crystals contain a large proportion of water of crystallization; and when exposed to a dry atmosphere, they effloresce and crumble into a white opaque powder.—The bicarbonate is prepared from the carbonate; and forms into very white

minute crystals, free from alkaline taste ; and is used medicinally for the same purposes as the carbonate, and for making extemporaneous effervescing draughts with tartaric and citric acids; but has no medicinal superiority over the carbonate, except that it is less nauseous.—The phosphate is prepared from the carbonate together with bones and sulphuric acid ; and forms into large, transparent, regular, oblique, rhombic prisms ; and has a purely saline taste similar to that of common salt ; and is used in medicine as a mild cathartic.—The acetate is prepared from the carbonate together with distilled vinegar ; and forms into solid striated oblique rhombic prisms ; and requires to be kept in closely-stopped bottles ; and has a sharp bitter taste ; and is used in medicine as a diuretic.

SOD-BURNING. See Paring and Burning.

SOFT GRASS. See Holcus.

SOIL. The covering or thin uppermost stratum of the earth's crust. It is understood by general observers as simply the ground, without any reference to either its depth or constitution or uses ; by geologists, as the superficial alluvial or diluvial deposit of the earth, to whatever depth it possesses homogeneity of character ; by botanists, as the portion of the earth's surface which supports vegetation, in all its classes and kinds, whether naturally or with the aid of culture ; and by farmers and gardeners, as the portion of the earth's surface which is stirred by the plough or the spade or otherwise subjected to tillage. The first of these four senses of soil is entirely popular, and does not recognise any subsoil, and is totally unsuited to any useful purpose, either scientific or technical ; the second refers solely to manner of formation and to mineral constituency, and recognises subsoil only in the sense of a substratum of different geognostic character from the soil, and therefore lying at depths varying from less than an inch to upwards of a thousand feet ; the third refers to the portion of surface, whether thin or thick, which, in the course of ages, has become impregnated with organic remains by the growth and decay of successive races of plants, and by either natural or artificial processes of manuring,—and it recognises as subsoil whatever lies immediately below this vegetation-supporting stratum ; and the fourth refers to any uniform depth of surface which is statedly or occasionally worked by tillage, whether only an inch or two by the most scratchy methods of barbarous husbandry, or from eighteen to thirty-six inches by the most elaborate methods of spade-trenching, plough-trenching, and subsoil-ploughing,—and it recognises as subsoil all the matter from the plane of the bottom of this stratum down to any depth, small or great, which can affect the circulation of moisture, air, and heat. Our work, of course, uses the word principally in the fourth sense,—in that of farmers and gardeners ; yet it also uses it occasionally in the third sense, or that of botanists,—especially in so far as this sense applies to cultivated land, and is quite or nearly synonymous with mould. The soil, in the farmer's sense, is sometimes of the same depth as the mould,—sometimes not so deep,—and sometimes deeper ; and it may rest on a subsoil either similar to itself or dissimilar, either homogeneous or heterogeneous, either workable or rocky, either deep or shallow ; and, with the exception of the characters resulting from profuse organic remains, tillage, and high atmospheric action, the subsoil may be as various in constitution and condition as the soil. Throughout the great majority of upland pastures, of rocky wastes, and of silicious, arid, uncultivated grounds, the soil is strictly coincident with the mould, and varies in depth from a shallowness scarcely appreciable to not more than a few inches ; and throughout the great majority of good arable lands, it either has naturally a great depth of all the requisites of fertility, or is capable of being artificially deepened to any degree which the demands of cultivation can require. In all the latter lands, too, however homogeneous any portion of it originally was with the subsoil, it has been so changed by artificial pulverization, by artificial supplies of organic matter, by artificial turnings of it to the action of the air and weather, and by the several other artificial accidents of cultivation, that it has now a finer texture, a darker colour, a richer impregnation of humus and salts, and altogether a different appearance and character.

The Formation of Soils.—The formation of the shallow soils of hills and mountains and rocky plains has rarely received aid from man, and has generally consisted in the disintegration of the rocky surfaces immediately below them, and in the natural progress and deposits of spontaneous vegetation. "The influence of heat and moisture tends to facilitate the gradual disintegration of even the hardest rocks ; and as soon as the smallest portion of loose matter or earth is formed on their surface, traces of an obscure vegetation begin to manifest themselves. Lichens of various kinds spring up, one generation succeeding another, until of their decayed and partially decomposed fragments, a soil is prepared for the reception of the mosses. These in their turn decay, and their decomposition affords a certain quantity of organic matter, which mixes with the disintegrated portions of the rocks ; and in this improved soil other kinds of plants are capable of subsisting. Meanwhile, the atmosphere still exerting its influence on the surface of the rocks, and the roots of the plants penetrating into their fissures, an augmentation to the mass of the soil is preparing, so that by such slow and gradual means a soil is formed, in which even forest trees can fix their roots. Thus that which was originally a bleak and ominous mass of rock, became capable of supporting successively the various tribes of plants, and fitted to reward the labours of the cultivator."

A large proportion of good deep arable soils, comprising the alluvial and the diluvial, were originally formed in the manner described in the articles ALLUVIUM and DILUVIUM; all moss-lands and peat soils were originally formed in the manner described in the article BOG; some arable lands were originally formed in a manner intermediate between shallow hill-soils and alluviums, having acquired their mineral constituents partly from disintegrations of the surfaces immediately below them and partly from the washed-down debris of the neighbouring declivities; and almost all cultivated soils, of whatever original formation, have undergone modifications first from the natural processes of spontaneous vegetation, next from the artificial processes of tillage and culture, and, concurrently with both of these, from the chemical action of air, heat, light, moisture, and the weather. See the article ALKALIES.

The Composition of Soils.—The composition of some soils is very largely silicious,—of others, very largely aluminous,—of others, very largely calcareous,—of others, very mixedly mineral,—and of others, chiefly or almost solely humous; and this wide diversity, with all its intermediate gradations, together with differences of mechanical condition, of subsoil, of situation, of climate, and of artificial or georgical character, gives rise to the classification of soils of which we must treat in the next section. But we speak here of the composition of soils in the aggregate; and we may represent them as comprising three great classes of bodies,—earths, salts, and organic matters,—and as, at the same time, involving a necessary and constant permeation by heat, moisture, and atmospheric gases. The earths, the salts, and the organic matters, are discussed separately and in a general way in respectively the articles EARTH, SALTS, and HUMUS; and all are also discussed, collectively, in their relations to the soil, in the articles MANURE and FOOD OF PLANTS. The three principal earths are discussed separately in the articles SILICA, ALUMINA, and LIME; and the forms or combinations in which they most commonly exist are discussed also in the articles SAND, CLAY, CHALK, and LOAM. A less common earth is noticed in the article MAGNESIA; and another mineral constituent of soil, the rust or oxide of iron, not properly an earth, and comparatively very small in amount, but plentiful enough to give much of it a reddish colour, and sometimes existing under such conditions as to act like a poison on plants, is noticed in the article IRON. The most important salts, whether as to bulk, as to economy within the soil, or as to nutritional connexion with plants, are discussed in the articles AMMONIA, NITRATES, PHOSPHATES, SILICATES, CARBONATES, SULPHATES, and ALKALIES. And the principal organic matters, whether those which accumulate by the decay of a long succession of different sorts of vegetables, or those which become soon abstracted from a virgin soil by constant cultivation, and require to be periodically supplied in the form of manure in order to maintain fertility, are discussed in the articles HUMUS, MOULD, EXCREMENTS, ANIMAL MANURES, and FARM-YARD MANURE. Connected views of the entire constitution of soils in their relations to vegetation and cropping, and of the slow mutations which they undergo during the processes of cultivation, are given also in the articles MANURE, AGRICULTURAL CHEMISTRY, and ROTATION OF CROPS.

All the constituents of soil exist as compounds, and perform their offices as compounds, and are obtained in analyses as compounds. The earths, for the most part, are oxides, or combinations of metallic bases with oxygen; the salts, for the most part, are double compounds, or combinations of either alkalies or alkaline earths with acids; and the organic matters are animal and vegetable principles in a decomposing state,—naturally very compound, and always passing by decay into other and less compound forms. The silica in soils commonly exists in mechanical combination, or intimate commixture, with alumina or oxide of iron, or with alumina, lime, magnesia, and oxide of iron, forming sand and gravel of different degrees of fineness. Most of the lime exists naturally in the state of carbonate,—most frequently in an impalpable form, but sometimes in the state of calcareous sand; and even when added artificially in the state of mere earth or oxide, it exists as a hydrate, and gradually passes into the state of a carbonate. The alumina commonly exists in an impalpable form, and in mechanical combination with minutely comminuted or very finely pulverized silica, lime, and magnesia, constituting the various kinds of clays, argillaceous earths, and clayey loams. The magnesia, when not combined with unreduced portions of gravel and sand, occurs in a fine powder in the state of carbonate. The salts occur variously in combination with the mineral matters, in combination with the organic matters, and in evolution or progressive formation from the elements or principles let loose by the gradual decomposition of other bodies. The organic matters occur in different states and stages of decomposition, from the slightest degree of appreciable decay to an ultimate resolution of all their principles into powders and gases, and are therefore variously compact, fibrous, pulverulent, pulpy, and aeriform.

All soils originally derived all their mineral constituents, directly or indirectly, from the disintegration of rocks; and they owe their distinctive mineral characters,—the predominance of one earth, the alternations of two or more, or the prevailing intermixture of several,—to the character and distribution of the rocks which yielded them. The several rocks were dissevered into parts and ground into powder of different degrees of smallness by the action of air and water and weather; solutions of some of their

saline constituents were formed in water, and diffused through the disintegrated masses, and deprived of their impregnations by the fragments and granules; and larger or smaller quantities of vegetable and animal remains, either produced on the spot, or brought down from higher grounds by rains and streams, settled down upon the surface, and became intermixed with the moistened minerals. Rocks of widely different constitution sometimes occur in close juxtaposition to one another within the upper regions of the same river-basin,—and then they give rise to a very diversified soil upon the hills, and to a very mixed alluvium upon the plains; but they sometimes occur also far asunder from one another, each kind or class forming the floor and walls of an entire basin,—and then they give rise to somewhat uniform soils upon both hill and plain,—the silicious rocks to sand and gravel, the aluminous ones to clay, and the calcareous ones to chalk or to limestone gravel.

Both the mixed soils from any given group or segregation of rocks, and the uniform soils from any one species or class of rock, are originally the same in all parts of the world; for so long as rocks of any one kind or class or grouping occur as sources of either detritus or alluvium, no matter where, their constituents are always the same, and must necessarily yield by disintegration the same sort of fragments and powder. Yet soils originally the same, or still minerally the same, differ widely and in many gradations from one another in consequence of mechanical condition, subsoil, situation, climate, and cultivation. The coarseness of granules or fragments, even in cases where the material is intrinsically suited to evolve the highest fertility, may be so excessive in itself, and so unrelieved by the presence of any finely divided matter as to render the soil absolutely barren. A soil of any kind immediately incumbent on rock or sand, especially in such wet districts as those of the west coast of Britain and the greater part of Ireland, may be comparatively dry, open, and fertile, while exactly the same soil incumbent on clay or marl or on an impervious compound of clay and sand may be marshy, close, and almost worthless. Any soil in a warm, dry country, is more absorbent of moisture, has a freer internal circulation, and makes richer accumulations of salts, alumina, and organic remains, than the same soil in a cold wet country. A soil upon a declivity makes better natural improvements, and is less exposed to natural deteriorating influences, than a soil upon a level; and one upon a declivity looking to the sun is superior in these respects, to one upon a declivity with any other exposure. Soils in wet, cold climates, with comparatively slow vegetable growth and comparatively little evaporation are liable to become choked with aquatic cryptogams, and even converted into sheer moors or bogs, while soils of the same kind in dry hot climates, with luxuriant vegetable growth and great and rapid evaporation, remain sound and open, and generally possess a constant, increasing, natural capacity of improvement. The ultimate composition of soils, therefore, is, in a very considerable degree, determined by the action or influence of subsoil, situation, and climate; and so very greatly is it affected by cultivation—in the processes of pulverization, of trenching, of fallowing, of cropping, and especially of manuring—that, in the case of many lands which have been specially reclaimed or have been long in tillage, the original character of it cannot be traced.

Classification of Soils.—A good classification of soils, together with a simple, fixed, comprehensive, and well-defined nomenclature, is essential for enabling farmers to form comparative estimates of the different soils of their own farm or district, to trace the resemblances between these and the soils of other districts, to decide how far any peculiar treatment of one soil may be profitably imitated upon another, to determine the kind and amount of mineral admixture which any soil may require for its proper textural amelioration, and especially to reap fair or full benefit, or even to obtain clear ideas or intelligible hints, from the multitudes of reports of valuable experiments on manures, methods of reclamation, improvements in culture, and other similar subjects, which abound in the agricultural periodicals of the day. The best which has yet been published is Schübler's of Germany, slightly altered by Dr. Daubeny, and founded entirely on the relative proportions of the four chief constituents of all soils,—clay, sand, lime, and humus. "In this," says Dr. Daubeny, "we begin with those soils which contain little or no calcareous matter—at the outside, not so much as 5 per cent. of the whole mass. These, supposing them to possess 50 per cent. of clay, are placed under the head of argillaceous soils, and are distinguished into two orders, the first wholly destitute of lime, the second containing less than 5 per cent. of that earth. Each of these orders is then subdivided into three species, distinguished as rich, poor, and intermediate, according to the proportion of humus or vegetable mould present in them. If the amount of this ingredient be not more than $\frac{1}{2}$ per cent. the soils are called poor, as the fertility of a soil is in all cases greatly influenced by the proportion of this ingredient; if it varies from 0·5 to 1·5 per cent., it is called intermediate; if from 1·5 to 5·0 per cent., it is distinguished as rich. The second class of soils comprehends those which contain from 30 to 50 per cent. of clay, and is denominated loamy. These likewise are divided into two orders, the one with, the other without lime; and again into three species, according to the proportion of vegetable mould present in them. The third class embraces those soils which contain not more than 30 nor less than 20 per cent. of clay. They are called sandy

loams, and are subdivided into orders and species, on the same principle as before. In the next or fourth class, under the denomination of loamy lands, are ranged those soils which contain from 10 to 20 per cent. of clay,—the remainder, with the exception of the small per centage of limestone and humus they may contain, consisting of sand. The fifth class, designated as sandy, includes all those soils in which the proportion of clay does not exceed 10 per cent.; and here again the same subdivisions are adopted. Hitherto, the amount of calcareous matter present is not supposed to exceed 5 per cent.; but in the next class, that of marly soils, the above ingredient ranges in a proportion varying from 5 to 20 per cent. of the whole. Marly soils are to be distinguished into five orders, of which the first, called argillaceous, contains about 50 per cent. of clay; the second, loamy, from 30 to 50; the third, sandy-loamy, from 20 to 30; the fourth, loamy-sandy, from 10 to 20; and the fifth is distinguished by the larger proportion of *humus*, which exceeds in quantity 5 per cent. of the whole, and is therefore denoted as *humous marl;* which last is divided into three species—viz., argillaceous, which contains about 50 per cent. of clay; loamy, which contains from 30 to 50 per cent.; and sandy, possessing from 20 to 30 per cent. of the same ingredient. We next arrive at that class of soils which contains more than 20 per cent. of carbonate of lime, and which is therefore distinguished as calcareous. These are subdivided according to the proportion of clay they may contain: when this earth exists in the proportion of more than 50 per cent., they are to be called argillaceous; when it is from 30 to 50, loamy; when from 20 to 30, they are said to belong to the sandy loams of the calcareous class; when from 10 to 20, to the loamy sands; and when either destitute of clay altogether, or containing at most only 10 per cent. of it, they are called sandy. Lastly, a calcareous soil which contains more than 5 per cent. of vegetable mould belongs to the sixth order, that of humous calcareous soils, of which there are three species—namely, the argillaceous, the loamy, and the sandy, characterized as before, by the larger or smaller proportion of clay present in them. The last class, that of humous soils, is distinguished in the first place, into three orders. The first consists of soluble mild humus—that is, of that description of vegetable mould which is in a fit condition to nourish the plants which grow in it; the second, of acid humus, namely, containing a free acid, which by its presence is highly destructive to most kinds of vegetation; a third order consists of fibrous vegetable matter, such as peat, which, though not acid, is yet in a condition little fitted for imparting nourishment to plants. These orders are again subdivided into argillaceous, loamy, and sandy, according to the proportion of clay present in them; and lastly distinguished into two species, the one containing, the other destitute of, calcareous matter."

The following table can readily be understood and used by any farmer, and ought to put an end to the loose and ambiguous phraseology which prevails in the popular nomenclature of soils, and might be of great service to the agricultural community till a better classification shall be made. But it is defective, as to the aids it should afford both to experimenting and to current farming, in not noticing the gradations of sand and gravel with respect to the size of their fragments and granules,—in not noticing the condition of the lime, whether powdery and artificially supplied, or in the state of natural chalk, or in the state of limestone gravel, or in the state of gypsum,—in not noticing the presence and proportions of the rarer and most fluctuating ingredients which play a main part in the nutrition of crops, such as the alkalies, the phosphates, and the nitrates, —and in not noticing the mighty modifications of the several soils, or the wide varieties in their existing fertility, which result from subsoil, situation, climate, drainage, cleanness, and agricultural treatment.

Names of the Different Descriptions of Soil.			Proportion in every 100 Parts.			Agricultural Designations and General Relations with Reference to their Produce.*
Classes.	Orders.	Species.	Clay.	Lime.	Humus.	
1. Argillaceous Soils. — Above 50 per cent. of Clay. More than 5 per cent. of Lime.	Without Lime.	Poor	Above 50	0	0 to 0·5	*Land for Wheat and Spelt.* The calcareous kinds not too rich in clay, and not too poor in sand and humus, give good returns. Wheat, spelt, barley, rape, beans, flax, and clover, flourish in it especially. Those poor in humus are still suited for oats.
		Interm.	„ 50	0	0·5 to 1·5	
		Rich	„ 50	0	1·5 to 5·0	
	With Lime.	Poor	Above 50	0·5 to 5·0	0 to 0·5	
		Interm.	„ 50	0·5 to 5·0	0·5 to 1·5	
		Rich	„ 50	0·5 to 5·0	1·5 to 5·0	
2. Loamy Soils. — Not more than 50 nor less than 30 per cent. of Clay. Not more than 5 of Lime.	Without Lime.	Poor	30 to 50	0	0 to 0·5	*Land for Barley.* The soils which are rich in humus, and contain lime, are well-suited even for wheat and spelt, and often approach nearly to the foregoing kinds. They are, moreover, suited for Triticum dicoccum? (Emmer), one-grained wheat (Einkorn), rye, oats, rape (Reps), flax, and clover.
		Interm.	30 to 50	0	0·5 to 1·5	
		Rich	30 to 50	0	1·5 to 5·0	
	With Lime.	Poor	30 to 50	0·5 to 5·0	0 to 0·5	
		Interm.	30 to 50	0·5 to 5·0	0·5 to 1·5	
		Rich	30 to 50	0·5 to 5·0	1·5 to 5·0	
3. Sandy Loams. — Not more than 30 nor less than 20 per cent. of Clay. Not more than 5 of Lime.	Without Lime.	Poor	20 to 30	0	0 to 0·5	*Land for Barley and Oats.* Less suited for wheat and spelt than the former soils, but even better adapted for Triticum dicoccum and T. monococcum, as well as for rye. Potatoes, turnips, and other roots thrive well in it.
		Interm.	20 to 30	0	0·5 to 1·5	
		Rich	20 to 30	0	1·5 to 5·0	
	With Lime.	Poor	20 to 30	0·5 to 5·0	0 to 0·5	
		Interm.	20 to 30	0·5 to 5·0	0·5 to 1·5	
		Rich	20 to 30	0·5 to 5·0	1·5 to 5·0	
4. Loamy Sands. — Not more than 20 nor less than 10 per cent. of Clay. Less than 5 per cent. of Lime.	Without Lime.	Poor	10 to 20	0	0 to 0·5	*Land for Oats and Rye.* Barley thrives well in those rich in humus. They are also well suited for buckwheat. Wheat, spelt, and clover do not succeed.
		Interm.	10 to 20	0	0·5 to 1·5	
		Rich	10 to 20	0	1·5 to 5·0	
	With Lime.	Poor	10 to 20	0·5 to 5·0	0 to 0·5	
		Interm.	10 to 20	0·5 to 5·0	0·5 to 1·5	
		Rich	10 to 20	0·5 to 5·0	1·5 to 5·0	
5. Sandy Soils. — Not more than 10 per cent. of Clay. Less than 5 per cent. of Lime.	Without Lime.	Poor	0 to 10	0	0 to 0·5	*Land for Rye.* Of less value; often cultivated only every third year, and the poor land often not at all. Those containing humus are chiefly fit for buckwheat, oats, hemp, tobacco, potatoes, and spergula arvensis.
		Interm.	0 to 10	0	0·5 to 1·5	
		Rich	0 to 10	0	1·5 to 5·0	
	With Lime.	Poor	0 to 10	0·5 to 5·0	0 to 0·5	
		Interm.	0 to 10	0·5 to 5·0	0·5 to 1·5	
		Rich	0 to 10	0·5 to 5·0	1·5 to 5·0	
6. Marly Soils. — More than 5, not more than 20 per cent. of Lime.	Argillaceous.	Poor	Above 50	2 to 20	0 to 0·5	Chiefly suited for wheat and spelt, together with lucern and sainfoin.
		Interm.	„ 50	5 to 20	0·5 to 1·5	
		Rich	„ 50	5 to 20	1·5 to 5·0	
	Loamy.	Poor	30 to 50	5 to 20	0 to 0·5	Less suited for wheat and spelt, more so for barley, Triticum dicoccum, and T. monococcum, but are amongst the most fertile soils.
		Interm.	30 to 50	5 to 20	0·5 to 1·5	
		Rich	30 to 50	5 to 20	1·5 to 5·0	
	Belonging to the Sandy Loams.	Poor	20 to 30	5 to 20	0 to 0·5	Barley and oats.
		Interm.	20 to 30	5 to 20	0·5 to 1·5	
		Rich	20 to 30	5 to 20	1·5 to 5·0	
	Belonging to the Loamy Sands.	Poor	10 to 20	5 to 20	0 to 0·5	Oats and rye.
		Interm.	10 to 20	5 to 20	0·5 to 1·5	
		Rich	10 to 20	5 to 20	1·5 to 5·0	
	Humous.	Clayey	Above 50	5 to 20	Above 5·0	The humous, and argillaceous marly soils are amongst the best which exist
		Loamy	30 to 50	5 to 20	„ 5·0	
		Sandy	20 to 30	5 to 20	„ 5·0	
7. Calcareous Soils. — Containing more than 20 per cent. of Lime.	Argillaceous.	Poor	Above 50	Above 20	0 to 0·5	The argillaceous soils often approach in value to the argillaceous marls; the remaining orders of both these classes equally correspond one with the other; to the most valuable belongs, as in the former case, the humous. Those wanting in humus require much manure. Those rich in clay are well suited for spelt and wheat; oats, Triticum dicoccum, lucern, and sainfoin thrive in them. Their value is much decreased by containing an excess of lime.
		Interm.	„ 50	„ 20	0·5 to 1·5	
		Rich	„ 50	„ 20	1·5 to 5·0	
	Loamy.	Poor	30 to 50	„ 20	0 to 0·5	
		Interm.	30 to 50	„ 20	0·5 lo 1·5	
		Rich	30 to 50	„ 20	1·5 to 5·0	
	Belonging to the Sandy Loams.	Poor	20 to 30	„ 20	0 to 0·5	
		Interm.	20 to 30	„ 20	0·5 to 1·5	
		Rich	20 to 30	„ 20	1·5 to 5·0	
	Belonging to the Loamy Sands.	Poor	10 to 20	„ 20	0 to 0·5	
		Interm.	10 to 20	„ 20	0·5 to 1·5	
		Rich	10 to 20	„ 20	1·5 to 5·0	
	Sandy.	Poor	0 to 10	„ 20	0 to 0·5†	
		Interm.	0 to 10	„ 20	0·5 to 1·5†	
		Rich	0 to 10	„ 20	1·5 to 5·0†	
	Pure.	Poor	0	„ 99	0 to 0·5	
		Interm.	0	„ 98	0·5 to 1·5	
		Rich	0	„ 94	1·5 to 5·0	
	Humous.	Clayey	Above 50	„ 20	Above 5·0	
		Loamy	30 to 50	„ 20	„ 5·0	
		Sandy	20 to 30	„ 20	„ 5·0	
8. Humous Soils. — Containing more than 5 per cent. or Lime.	Soluble mild Humus.	Clayey	Above 50	With or	Above 5·0	The value of these soils is greatly augmented by admixture with lime. Those which contain lime and clay are suited for wheat, spelt, barley, and oleaginous plants; the loamy and sandy are especially adapted for oats, and in most places for wheat. The peaty and acid humous may be made fruitful by admixture with lime, sand, and clay.
		Loamy	30 to 50	without	„ 5·0	
		Sandy	20 to 30	Lime.	„ 5·0	
	Insoluble carbonized or acid Humus.	Clayey	Above 50	With or	„ 5·0	
		Loamy	30 to 50	without	„ 5·0	
		Sandy	20 to 30	Lime.	„ 5·0	
	Insoluble fibrous Vegetable matter.	Bog and Peat Earth.	With Lime.		„ 5·0	
			Without Lime.		„ 5·0	

* This, of course, chiefly applies to the soil and climate of Germany. † Remainder,—any portion of sand, less than 80 per cent.

The Characters of Soils. — The compositional characters of soils have already been sufficiently adverted to in the section on the "Composition of Soils;" and their adaptational characters, for the various kinds of ordinary cropping, are instructively glanced at in the last column of the tabular classification of soils which we have given from Schübler. But their economical characters, or those which concern the facilities and rewards and accidents of tillage,—their indicational characters, or those which reveal important intrinsic properties through the medium of colour,—their relative chemical characters, or those which concern the kind and degrees of connexion with the chemical agencies of the atmosphere,—their relative geological characters, or those which concern the kind and degree of connexion with the agencies and influences of the subsoil, — and their intrinsic mutational characters, or those which concern the changes or fluctuations of constitution resulting from successions of vegetable growth,—all these also claim to be well understood; and we shall here devote a paragraph to each class.

The economical characters of soils comprise a subclass which might be called the mechanical, and they also impinge upon, or partially comprise, some of the compositional, the chemical, and the geological; yet they constitute a sufficiently distinct class, and eminently deserve to be treated as one on account of their mutual connexions and their aggregate importance. A stiff or heavy soil is one difficult to be worked, such as most clays; and a free or light soil is one easy to be worked, such as all sands and gravels, most loamy sands, and some sandy chalks and limestone gravels. A hard soil is one which constantly tends to dry cohesion and dry cloddiness, however well or often worked; and a soft soil is one which constantly tends to crumbliness and incohesion, in consequence of being too silicious, or too often ploughed, or too much marled. A wet soil is one which is continually so, or which cannot easily or long be put into the opposite condition, such as a clay upon a retentive subsoil; and a dry soil is the opposite of a wet one, such as sand or loamy sand upon an open subsoil. A retentive or close soil is one which does not allow the ready permeation of surface water, but holds much of it till it be dissipated by evaporation; and an irretentive or open soil, is one which readily allows the infiltration of water, and holds no collections or stagnations of it either on the surface or in the interior. A smooth soil is even and slippery when wet; a rough soil is irregular and corrugated when dry; a coarse soil consists, in a considerable degree, of large granules and unreduced boulders and fragments; a fine soil is either minutely granular or, in a considerable degree, impalpably powdery; and a fine-skinned soil assumes either a smooth or a finely granulated surface when finished off by tillage. A deep soil comprises a great depth of mould or of alluvium, or has a somewhat uniform composition from the surface down to a greater depth than the plough can reach; and a thin or shallow one comprises a comparatively thin stratum of mould, and passes soon into the botanical subsoil, but, in many instances, is capable of being easily deepened by courses of tillage, trenching, cultivation, and manuring. A rich soil yields a large return of produce for a moderate quantity of manure; and a poor one yields only a middling or even small return of produce for an enormous quantity of manure. A grateful soil yields larger returns of produce than might be fairly expected from the labour and manure bestowed upon it; a kindly soil makes a regular and steady and corresponding return for every ameliorating operation performed upon it; a churlish one yields smaller returns of produce than might be fairly expected from the labour and manure bestowed upon it; and a hungry one yields ordinary returns of produce, or is maintained in a moderately fertile condition, only when it is dosed with large and frequent supplies of manure. A sharp soil is either a warm, dry, and early one, bringing crops to a speedier maturity than other soils in the same circumstances of subsoil, situation, climate, and georgy,—or it is a peculiarly open one, which contains so large a proportion of small gritty stones as quickly to clear up the plough-irons; and a deaf soil is the opposite of a sharp one in the latter sense, containing so large a proportion of soft, spongy, inert vegetable matter as to act chokingly against the plough or be carried forward on its bosom.

The colours of soils, regarded as indicational characters, reveal in some instances the constitution of soils, in others their economical properties, in others their chemical capacities, and in others the changes which they undergo from cultivation. A black humous soil consists mainly of crude peat or of deep vegetable mould, and is rapidly absorbent of heat, and has been observed to rise, in one hour, by simple exposure to sunshine, from a temperature of 65° to a temperature of 88°. A white calcareous soil contains a large proportion of chalk, and is very slowly absorbent of heat, and has been observed to acquire only 4° of additional temperature in the same circumstances in which a black humous soil acquired 33°. Brown and red soils acquire comparatively high degrees of temperature, and, in common with the black, are called warm soils; and yellow, pale, bluish, and grey soils acquire comparatively low degrees of temperature, and, in common with the calcareous white, are called cold soils. Brown and red soils vary in gradations of hue from hair-auburn to dark chestnut, and include the rich and numerous sub-class popularly called hazel soils, and owe their characteristic tints to various combinations of oxide of iron, and comprise a large proportion of the loamy soils, the sandy loams, and the loamy sands. Yellow, pale, grey, and bluish soils com-

prise most of the argillaceous soils, and a few of the stiffest loams. Black soils are often churlish and generally deaf; brown soils are often kindly and generally sharp and grateful; and red soils are always rich. The yellowish grey, the dull red, and the dull brown are very little or not at all altered in tint by cultivation; but the bluish, the yellow, and the bright red become darker and duller by ploughing and manuring.

The relative chemical characters of soils, both with reference to atmospherical connexions and with reference to intrinsic action, are very powerfully and variously modified by the circumstances of drainage. See the article DRAINING.—The circulation of air through soils, together with free play to the important action of oxygen, is mightily controlled by natural porosity, and by all those operations of georgy and culture, by which porosity is artificially increased or maintained. See the article AERATION.—The absorption of carbonic acid, ammonia, phosphuretted hydrogen, sulphuretted hydrogen, and other importantly nutritional gases which either float in the atmosphere or ascend toward it from the decomposition of organic remains and of putrescent manures, is effected far more by some soils than by others,—and most of all by such as possess a maximum of carbonaceous matter in a state akin to that of charcoal. See the article ABSORPTION IN CHEMISTRY.—The various absorption of heat by different soils has already been adverted to in connexion with the colour-characters; and may here be further noticed in the words of Sir Humphrey Davy, "Some soils are much more heated by the rays of the sun, all other circumstances being equal, than others, and soils brought to the same degree of heat cool in different times, that is, some cool much faster than others. This property has been very little attended to in a philosophical point of view; yet it is of the highest importance in agriculture. In general, soils that consist principally of a stiff white clay are difficultly heated; and being usually very moist, they retain their heat only for a short time. Chalks are similar in one respect, that they are difficultly heated; but being drier they retain their heat longer, less being consumed in causing the evaporation of their moisture. A black soil, containing much soft vegetable matter, is most heated by the sun and air; and the coloured soils, and the soils containing much carbonaceous matter, or ferruginous matter, exposed under equal circumstances to the sun, acquire a much higher temperature than pale-coloured soils. When soils are perfectly dry, those that most readily become heated by the solar rays likewise cool most rapidly; but I have ascertained by experiment, that the darkest coloured dry soil, (that which contains abundance of animal or vegetable matter, substances which most facilitate the diminution of temperature,) when heated to the same degree, provided it be within the common limits of the effect of solar heat, will cool more slowly than a wet pale soil, entirely composed of earthy matter."—The retention of the decomposing substance or of the recombined principles of organic remains, especially as artificially supplied in the form of manure, is much greater and more economizing by argillaceous and loamy and calcareous soils than by silicious ones, or by sandy soils containing a considerable intermixture of lime or chalk than by mere sands and gravels.—Close soils and open ones are very differently affected by frost and thaw. All clays and stiff loams, in consequence of the great expansion which results from the freezing of the water in their interstices, are more dissevered and disintegrated by frost than by the most elaborate tillage; and when thaw comes, they are left open and porous, freely exposed to the circulation of air and moisture, which decomposes their alkaline constituents, elaborates their stores of inorganic nutriment for plants, and renders their whole mass almost as powdery and "mellow" as that of naturally open soils. But sands, loamy sands, many calcareous and humous soils, and even some sandy loams, when frozen soon after rain, or otherwise in a wet state, are so greatly expanded as to be icy and resonant; and, when thawed, they retain their increased bulk, and have a largely cellular or honeycombed texture, and suffer erosion and winnowing by the excessive permeation of air, and allow their young plants, particularly wheat and red clover, to be loosened from their root-hold, "thrown out," and either ruptured or starved to death.—The absorbing of moisture from the air in dry conditions of the ground, so as by its imbibitions during the night to counteract the effect of evaporation during the day, is a function eminently connected with fertility, and is performed in widely different degrees by different soils. Very powdery or finely pulverized soils of any one kind absorb much more moisture than coarsely granular or badly tilled ones of the same kind; and humous substances in any soil absorb more moisture than fine carbonate of magnesia,—fine carbonate of magnesia more than garden mould or grey pure clay,—garden mould or grey pure clay more than loamy clay or slaty marl or sandy clay,—and any of these three very greatly more than gypsum powder, calcareous sand, or silicious sand. The stiff clays approaching in nature to pipe clays, which imbibe the greatest quantity of water when it is poured upon them in a liquid form, do not by any means absorb the greatest quantity of moisture from the atmosphere in dry weather, but consolidate and contract and present a diminished and close surface to the air, and become arid and exsiccated, and eventually allow their vegetation to be almost as severely burnt up as on sands. Soils, on the other hand, which are not remarkable for imbibing large doses of water in its liquid state, but which have an open texture and a finely divided condition,

and which contain a fair proportion of loamy clay and vegetable matter, absorb large supplies of moisture from the atmosphere in dry weather, and at the same time do not become cohesive or pultaceous after rains. The following table from Schübler shows the quantity of moisture absorbed from the atmosphere, in respectively 12, 24, 48, and 72 hours, by 1,000 grains of each of 13 substances, spread on a surface of 50 square inches:—

Substances.	In 12 hours.	In 24 hours.	In 48 hours.	In 72 hours.
Silicious sand	0	0	0	0
Calcareous sand	2	3	3	3
Gypsum powder	1	1	1	1
Sandy clay	21	26	28	28
Loamy clay	25	30	34	35
Stiff clay	30	36	40	41
Grey pure clay	37	42	48	49
Fine carbonate of lime	26	31	35	35
Fine carbonate of magnesia	69	76	80	82
Humus	80	97	110	120
Garden mould	35	45	50	52
Arable soil	16	22	23	23
Slaty marl	24	29	32	33

The relative geological characters of soils, or those which involve their connexion with the agencies and influences of the subsoil, have reference partly to their original constitution, partly to the local facilities for improving them, and partly or even chiefly to the circulation of moisture through them or to the circumstances of their drainage.—Soils which rest directly upon solid rock, whether on hill or plain, generally owe their mineral constituents to the disintegrations immediately below and around them; so that their general nature and value, in so far as these depend upon their mere original composition, may be accurately estimated by reference to the geognostic formations on which they lie. Soils formed directly on granite, quartz, serpentine, and generally on silicious primitive rocks are barren; those formed directly on magnesian limestone are bad; those formed directly on all tolerably pure calcareous limestones are productive; those formed directly on the shales and sandstones intermediate between the transition and the tertiary rocks, are bad, indifferent, or good, according to the predominance of silica in the rocks or to the degrees of its intermixture with alumina and lime; and those formed directly on the basalts, greenstones, and porphyries of the trap rocks are generally fertile. See also some statements in the article Barren Soils. —Soils which rest upon earthy strata may, when properly worked by intelligent and skilful husbandry, owe more of their practical worth or worthlessness to the depth and the nature of these strata than to their own composition When the under-strata are deep and porous, no expense requires to be incurred for forming and maintaining a system of artificial subsoil drainage; when they are comparatively rich in organic matter and in alkalies and salts, they afford a ready mine for the deepening or renovating or enriching of the soil by the simple process of trenching or trench-ploughing; and when they contain a supply of any necessary ingredient in which the soil is deficient, or which would tend to improve it, as of clay beneath sand or of limestone gravel beneath peat, they offer the amplest facility for effecting improvement by textural intermixture. But, on the other hand, when the under-strata are stubbornly retentive, a system of artificial subsoil drainage is essential to fertility; when they are poor in organic matter and in salts, and especially when they contain noxious metallic oxides, they would injure the soil, and not improve it, by being trenched up; when they are minerally the same in nature as the soil, they offer little or nothing for textural improvement; and when they are porous and lie very near the surface, they both starve all deep-rooting plants, and occasion a rapid exhaustion of internal moisture at a time of drought.—The strata immediately beneath the soil, whether they be solid or earthy, differ widely in their effects upon the circulation of air and moisture, or upon all those properties of soil which are dependent on drainage.

The mutational characters of soils might be so comprehensively defined as to comprise all sorts of changes whatever which take place in soils both naturally from the agencies of meteorology, chemistry, and vegetation, and artificially from the operations of georgy, tillage, manuring, and cropping; but they are understood here in so restricted a sense as to comprise only the changes and fluctuations which result from successions of vegetable growth, partly in a natural way, but chiefly in courses of cropping; and even as thus limited in meaning, they present to the farmer a great and diversified and eminently important subject of study,—no less, in fact, than the whole question of constant mutations in composition and fertility arising, on the one hand, from the withdrawal of ingredients by unreturned weeds, crops, and cattle, and, on the other, from the adding of ingredients through the medium of fallowing and of feeding-off and in the form of manure. The subject, however, belongs rather to the chapter of current cultivation than to the chapter of soils, and has already been pretty fully discussed, though in an incidental way, in the articles Manure and Rotation of Crops; and it is introduced here principally for the sake of reminding intelligent farmers that, in the present advanced state of agricultural science, they may enjoy the luxury and reap the benefit of keeping an estimate-account of the fluctuating powers of every field, so as to show at a glance the balance between fertility withdrawn by crops and stock and fertility imparted by ameliorations and manurings,—and of presenting to them the following table, by the help of which, along with that of the analyses of the several manures given in their proper places, they may see the principles on which such an account must be framed:

100,000 lbs, or about 50 tons of	Contain of Volatizable Ingredients—in lb.		Fixed Ingredients—in lb.											
	Water and Carbon.	Azote.	Potash.	Soda.	Lime.	Magnesia.	Alumina.	Oxide of Iron.	Oxide of Manganese.	Silica.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Total of fixed Ingredients.
Wheat . Triticum vulgare . .	97,625	238	225	240	96	*690?	26	trace	trace	400	50	†400?	10	2137
Wheat-straw	96,452	30	20	29	240	32	90		...	2870	37	170	30	3518
Barley . Hordeum distichum .	97,449	202	278	290	106	180	25	trace	...	1182	59	210	19	2349
Barley-straw	94,730	26	180	48	554	76	146	14	20	3856	118	160	72	5244
Oats . Avena sativa . . .	97,200	222	150	132	86	67	14	40	...	1976	35	70	10	2580
Oat-straw	94,224	36	870	2	152	22	6	2	2	4588	79	12	5	5740
Maize . Zea mays . . .	98,488	200	200	250	35	128	16	trace	...	434	17	224	8	1312
Maize-straw	95,800	229	189	4	652	236	6	4	20	2708	106	54	6	3967
Rye . Secale cereale . .	98,731	229	532		122	44	24	42	34	164	23	46	9	1040
Rye-Straw	97,187	20	32	11	178	12	25		...	2297	170	51	17	2793
Potatoes . Solanum tuberosum, the tubers	99,006	180 moist only 37	390	234	33	32	5	$2\frac{3}{4}$	...	$8\frac{1}{3}$	54	40	$15\frac{1}{2}$	814
Beans . Vicia faba . . .	97,351	513	415	816	165	158	34	traces	...	126	89	292	41	2136
Bean-straw (dry)	97,879		1656	50	624	209	10	7	5	220	34	226	80	3121
Vetches . Vicia sativa . .	97,710		897	622	160	142	22	9	5	200	50	140	43	2290
Vetches (the straw)	94,899		1810	52	1955	324	15	9	8	442	122	280	84	5101
Pease . Pisum sativum . .	97,128	408	810	739	58	136	20	10	...	410	53	190	38	2464
Pea-straw	95,029		235	traces	2730	342	60	20	7	996	337	240	4	4971
Lucern . Medicago sativa, in a green state = 27,000 when dry . . .	97,390	30 when dry 166	362	166	1304	94	8	8	...	90	109	353	86	2580
Sainfoin . Hedysarum onobrychis, in a green state=24,000 when dry . . .	98,329		494	105	527	69	16	traces	...	120	82	220	38?	1671
Red Clover Trifolium pratense, in a green state=24,000 dry	98,253	176 when dry 277	419	111	584	70	3	traces	traces	76	94	138	76	1571
Flax . Linum usitatissimum .	97,660		438		630	234	2	traces	...	120	24	880	12	2340
Beet . Beta vulgaris, roots dried	93,744	270 fresh gathd. 26	1481	3178	285	139	20	58	50	105	123	167	380	5986
Beet . Leaves dried . . .	84,561		5600	3290	2316	839	130	50	60	425	975	690	1064	15439
Cabbage or Rape . Brassica campestris oleifera, plants with their roots dried in the air.	92,542	550	1847	578	1822	202	11	151	40	529	774	436	518	6908
Turnips . Brassica rapa, fresh gathered, in which state they contain nine-tenths of water . .	99,427	17 when dry 220	72·9	109·8	127·2	22·3	8·0	2·1	1·7	40·5	41·1	73·4	23·1	555·8
Swedes or Ruta Baga . Brassica oleracea napobrassica, dried in the air	92,954		2651	1164	835	282	40	35	...	475	890	408	266	7046
Cow-parsnip. Heracleum sphondylium, green=14 parts of do. dry	98,496		501	78?	400	97	11	9	...	84	79	128	117	1504
Carrots . Daucus carota, roots dried in the air . .	94,670	240 when green 30	2718	709	505	295	30	25	46	105	208	395	54	5090
Comfrey . Symphytum asperrimum, in a green state=12,000 dried	97,701		720	250	473	29	9	traces	...	395	89	262	72	2299
Buckwheat . Polygonum fagopyrum, grains . . .	98,406	240	204	330	156	183	26	8	44	144	74	170	15	1354
Meadow-Catstail. Phleum pratense, in a green state=46 dry	98,378	106?	291	180	152	35	11	traces	...	742	39?	66	...?	1516
Rye-grass . Lolium perenne, in a green state=32 dry .	98,201	106?	282	126	236	29	10	traces	...	887	113?	8?	2?	1693
	Boussingault.		Sprengel.											

* So in Sprengel, but we probably ought to read 69·0.

† In Sprengel 40·0, but this is a manifest misprint.

The Offices of Soils.—Soil affords mechanical support to plants growing in it. Plants can neither stand of themselves on the surface of the ground, nor move from place to place in quest of their daily food, but require to remain long on one spot, and there to send their roots downward, and to spread their radicles beneath the surface. And the soil is exactly adapted to their wants. Being a finely divided solid, it permits their roots and radicles to push through it in all directions; and being, at the same time, closely aggregated, it holds them sufficiently fast to prevent them from falling by their own gravity, and from being torn up or overwhelmed by ordinary winds; and being also permeated by air and moisture, it maintains them in the precise position and circumstances which are suitable to their constant feeding. The different kinds of soil, too, have exactly the varieties of texture which are best adapted to the form and habits and wants of the particular species of plants which naturally inhabit them.

Soil supplies part of the inorganic food of plants, and serves as a ready vehicle for the reception of other parts. Its stores of silica, alumina, and lime afford supplies of the nutrimental principles derivable from them, which are in many instances inexhaustible,—and in most of at least long continuance; and its mechanical condition and capacities receive in the readiest manner all sorts of natural and artificial additions of other nutrimental substances, and store them up in ways which both make them most facilely accessible to the roots of plants, and most effectually prevent their waste or dissipation by interfering causes.

Soil acts as the stomach of plants, or as the laboratory in which their food is prepared for absorption by their spongioles. The substances which yield this food, whether as they exist naturally in virgin soils or as they are artificially added to soils which have been long in cultivation, require in some instances to be dissolved, and in most to be also decomposed and recombined before they assume the form of food; and at the same time, either the substances themselves or the principles which result from them must be so diffused, economized, and progressively reduced as to afford a continuous contribution of nourishment around all the parts and periphery of each plant's roots, throughout the whole period of its existence. The powers by which the soil achieves so great and complicated results are mainly its own mechanism, the chemistry of its own ingredients, and the agencies of moisture, air, heat, light, and electricity; and the methods and intricacies in which these work and co-operate, so far as they have been yet investigated, are a most imposing instance of the beauty and complexity, the wisdom and magnificence of the physical ordinances of the all-beneficent Creator. A simple glimpse at them—sufficient for farming purposes, and also for setting the mind a-thinking—is afforded by the following extract from a paper by Dr. Madden:—"The mineral or permanent constituents of soil are capable of being divided into two distinct classes, independently of their chemical nature, viz., into coarse and fine, or into visible particles and impalpable powder. The impalpable matter of soil contains all its most important ingredients; for the remainder, or coarse particles, contains, in addition to pure mineral matter, merely the crude undecomposed vegetable fibre, &c., which is utterly useless to plants until, by putrefaction or otherwise, it becomes disintegrated and intimately combined with the impalpable matter. The use of the coarser parts is therefore merely to render the soil more permeable to moisture, air, heat, &c., and in this manner to assist mechanically in the preparation of the food of plants. When manure is added to soil, the following series of changes takes place:—1. The soluble matters are washed away from the straw and other undecomposed substances, by the first rain that falls, and, sinking into the earth, are immediately absorbed (supposing no plants are growing in the neighbourhood) by the impalpable matters of the soil. 2. If the soil should not have been previously rich, a certain quantity of the soluble manure will enter into chemical combination with the sand, clay, and chalk, of which the impalpable matter is composed, and thus be rendered insoluble, and consequently for the present useless. 3. But should the finely divided parts of the soil be already saturated with organic matter,—which, however, as above stated, will have been rendered insoluble by chemical combination,—the newly added soluble matter is, nevertheless, absorbed by the mass, although now it acts in a totally different manner. 4. The soluble organic matter of manure, when brought into contact with insoluble organic matter, of whatever origin, acts as a ferment upon it, and causes it to undergo various changes, by which the chemical attraction between it and the clay, sand, chalk, &c., are overcome, and consequently it again becomes free in a soluble state, or, in other words, in a fit state for absorption by plants. 5. But when, by the operations of tillage, any part of the chemically combined organic matter is brought sufficiently near the surface to come freely in contact with air, a different series of changes takes place; oxygen is absorbed, and the organic matter is in this manner changed in its nature, and rendered much less easily decomposed, and, in fact, although no longer combined with the clay, chalk, &c., requires the addition of fermenting matters, or some alkaline salt, in order that it may be again rendered capable of solution. 6. At this point, the saline impregnations of soil come into play, and none more so than common salt or muriate of soda. This exists in almost every manure, so that it very generally is to be found in all cultivated soil. When this salt is brought into con-

tact with carbonate of lime (chalk), a gradual change takes place, and the resulting compounds are muriate of lime and carbonate of soda; which latter is a powerful alkali, and is of great value, on account of its capability of acting upon oxidized organic matter. 7. Thus the organic matter has again become combined with saline matter, but this time it forms a very soluble salt, which consequently is absorbed by plants, and is more useful than it would have been previously, because it is more highly oxidized. 8. As, however, the plants do not require so large a quantity of alkaline matter as they would in this way receive, the superabundant portion is returned to the soil, with other excrementitious matters, and thus, by coming into contact with the muriate of lime, produced in the manner formerly related, a contrary change takes place, and carbonate of lime and muriate of soda are reproduced. For, strange as it may appear to those not conversant with chemistry, although carbonate of lime and muriate of soda, when in contact in a moist state, are gradually converted into muriate of lime and carbonate of soda, still, if these latter salts meet together in solution, they immediately resume their former state of chalk and common salt. These are a few of the very complicated changes which are constantly occurring in soil; but a careful consideration of them will enable us to draw the following important practical deduction, viz., that multitudinous as they appear, still soil is so admirably adapted for the duties which it has to perform, that the farmer has merely from time to time to add fermenting matters to his soil, and he may rest assured of his plants never lacking their proper nourishment."

The Peculiar Vegetations of Soils.—Many plants prosper equally on many kinds of soils and in widely different situations; most are diffused over a great diversity of surface by means of some one or more of the mighty agencies which are everywhere at work for covering all the earth with vegetable wealth and beauty; and few are so entirely dependent on the composition and depth and texture of soils, irrespective of capacity for the free play of heat and moisture and atmospheric influences, as to afford invariable indication of the mineral and economical and chemical characters of the ground on which they grow. Yet some great groups and families of them always affect peculiar conditions of land or water or elevation, and therefore make striking intimation of the presence of these conditions wherever they exist. "Thus," to adopt the words of Professor Macgillivray, "if, while traversing an extended heath, we observe at a distance a spot covered with fresh verdure, we infer that the soil there is certainly not peat; and if, on approaching it, we see poæ, viciæ, and other plants usually found in rich pasture, we infer that the soil is vegetable; and so of other soils. If, on the other hand, in a rich country, we see tracts, whether of hill or plain, covered with a brown vegetation, which we know to be heath, we infer that the soil is peat. Still, even among these general appearances, there are few that have direct reference to soil. Thus, on seeing a long line of trees, which we know by their physiognomy to be alders or willows, we infer that a river flows beside them, but we can make no inference with respect to the soil. And thus, were it possible that we should be led blindfolded to a spot, in which we should open our eyes upon a rivulet, margined with bright green moss, among which *Saxifraga stellaris, Alchemilla alpina, Silene acaulis,* appeared here and there, we might assuredly pronounce ourselves in an alpine region; but what the peculiar soil of the spot might be, we would require to remove the turf to discover, and thus trust to the colour, texture, adhesion, and other qualities of the soil itself for a disclosure of its nature, rather than to anything growing upon its surface. Thus we see that Nature, simple in her grand plans, yet complex even to infinity in her details of execution, presents nothing of which we can acquire a tolerable knowledge, by viewing it on one side only, or which the mind can grasp by employing a single principal or pervading idea for that purpose. The grand principle of vegetation is simple in its design; but view it in detail, and its complication astonishes and bewilders. To become the abode of animals, it was necessary that the earth should be covered with vegetables; but from the cedar of Lebanon to the small plant (whatever that may be) that grows on the wall, from the magnificent jagua of tropical America to the diminutive radiola of northern Europe, not to take other examples still more striking, how multiplied the proportions, the forms, the colours, the qualities of all kinds, and how different the circumstances! It is the same sun that calls forth, and, when thus elicited, gives vigour to the vegetation, the same earth that supports it, the same moisture that swells its vessels, the same air that furnishes the medium in which it lives; but amid all this singleness of general, how multiple the variations of partial or constituent causes, and how infinitely diversified their results!"

The comparatively few British plants, however, which have a certain and uniform character of habitat, perform a valuable service to intelligent observers, in some cases by indicating the presence or predominance of certain constituents in the soil, in others by indicating the aggregate composition of the soil, in others by indicating the comparative states of different specimens of soil of the same generic composition, in others by indicating the pressure or excessive power of some deteriorating influence which is capable of correction, and in many by suggesting or revealing errors which have been committed in the management of land or methods which may be adopted for reclamation or enrichment. We

shall here give two sets of indications, the one in an extract from a paper by Professor Macgillivray, and the other in a digest of a paper by Mr. Gorrie,—the former showing in a general way the peculiar vegetations of different kinds and conditions of British soils, and the latter showing the characteristic wild vegetation of each principal kind of soil in respectively its natural and its cultivated states.

"Loose sand requires no indications by vegetables, its nature being rendered too obvious by other circumstances. Luxuriant tufts of Arundo arenaria, either by itself, or mixed with Triticum junceum, Galium verum, and some other vegetables, frequently occur in this soil. Calcareous sand and silicious sand are not distinguished apart by any peculiar plants. They may, however, be readily distinguished by simple inspection. Intermixture of pasture plants, and especially Galium verum, Achillæa millefolium, and grasses, with Arundo arenaria, indicate that the sand is more or less fixed, and that it is tolerably well secured against drifting. The existence of peat is invariably indicated by Calluna vulgaris, Erica cinerea, E. tetralix. It is to be suspected also wherever Myrica gale, Droseræ, Eriophora, numerous Carices, and Melica cœrulea appear. Soft, friable, scaly or laminar peat, is indicated by a vegetation consisting chiefly of Calluna vulgaris, Erica cinerea, Melica cœrulea, intermixed with Carices, Junci, Scirpi, Mosses, and Lichens. Fibrous, tenacious, spongy peat, is indicated by a vegetation consisting chiefly of Cyperaceæ, Carices, Scirpi, and Junci, especially Juncus cæspitosus and Eriophorum vaginatum, with comparatively little heath. Compact, brittle, hard peat, is indicated chiefly on declivities and in elevated situations by a vegetation consisting in a great part of Gramineæ, such as Melica cœrulea, Aira flexuosa, together with Cyperaceæ and heath. The softish friable peat in which remains of ligneous vegetables occur, is not indicated by any peculiarity of vegetation differing from that indicative of the first kind of peat mentioned. It is almost always to be found in low and level places, and is frequently swampy at the surface, with great tufts or islets, covered with heath. Calluna vulgaris or Erica cinerea, when luxuriant and close, indicate a gravelly soil at no great depth. Pinus sylvestris growing in peat indicates that it is thin, and that the subsoil is sandy or gravelly. Scirpi, Carices, and Eriophora, thriving in peat, indicate an abundant supply of moisture, owing either to a subsoil of clay or solid rock. On the contrary, a vegetation stunted, and liable to be burnt up in dry weather, indicates, in general, dryness arising from a subsoil of sand. The cessation of Erica and Calluna upon mountains indicates either the cessation of peat soil, or approximation to the line of snow. On open heaths, Trientalis europæa and Anemone nemorosa indicate great dryness, and manifest a disposition favourable to the growth of Pinus sylvestris, if planted on them. Heath overgrown or much intermixed with lichens, indicates too great an elevation for the successful cultivation of corn. The same indication is made by the existence of alpine plants, such as Saxifraga stellaris, Veronica alpina, Thalictrum alpinum, &c. Great profusion and luxuriance of Scirpus cæspitosus in low heaths, indicate that, although excellent for summer pasturage, they are unfit for wintering, from their great wetness. The existence of any other tree than Pinus sylvestris in peat soil, shows that the subsoil comes very near the surface. With respect to cultivation of peat soil, some indications are also furnished by the plants growing in it. Peat, of which the surface is even, and continuously covered with Calluna or Erica, is in general capable of being taken in, because the gravel comes so near the surface that it may be reached by the plough. On the other hand, low tracts of peat, with great tufts of heath, separated by bogs, are incapable of being reclaimed, without previous draining, and, after all, the peat is too deep to form a tolerable soil. Spongy, fibrous peat is the most intractable of all the varieties, because, from its tenacity, it cannot be made to mingle with gravel or sand. The great mass of vegetation, or, as it may be called, the standard vegetation of the country, being diffused over every sort of soil, sandy, gravelly, gritty, clayey or vegetable, no particular indications are afforded by it of the nature of the soil, unless with respect to its luxuriance, which yet depends upon other circumstances, more than upon the quality of the soil. Trifolia, Viciæ, Lathyrus pratensis, mixed with grasses, forming the principal part of the vegetation, and growing luxuriantly, indicate a good vegetable soil, well supplied with moisture. Abundance of Thymus serpyllum indicates not so much any particular soil, as dryness of soil, or great thinness. Senecio Jacobæa, in general, indicates a good depth of good soil. Linum catharticum, Thymus serpyllum, Apargia autumnalis, Hieracium pilosella, indicate dry, if not gravelly or sandy soil, in pasture grounds. Iris pseudacorus, Juncus acutiflorus, Cardamine pratensis, and Lychnis flos-cuculi, in such, indicate a good soil, with a plentiful, or more frequently an overabundant, supply of moisture. In pasture-grounds, in general, the existence of Poa trivialis, Triticum repens, Potentilla anserina, Plantago lanceolata, P. media, Senecio Jacobæa, indicate a soil of good quality, capable of being cultivated with advantage. A stunted and, in hot weather, burnt-up herbage, indicates the approximation of the rock to the surface, or extreme dryness of soil. Sandy pasture-grounds are always characterized by a peculiar fineness of vegetation, producing a comparatively large portion of the most nutritious species, excepting when furze or broom has got into them, in which case these plants frequently banish or choke up the more useful kinds. An intermixture, however small, of Erica or Calluna with pasture plants, indicates that the soil is more or less peaty; Orchideæ, and especially Orchis maculata, abundant in pasture-grounds, affords the same indication. Pteris aquilina, in such grounds, especially when the other vegetation consists chiefly of grasses, affords a very favourable idea of the soil, which has commonly a large proportion of vegetable earth in it, where this plant grows luxuriantly. Gravelly or gritty soil is indicated by the poverty of the vegetation. Aira caryophyllæa, A. præcox, Rumex acetosella, are among the ordinary inmates of such soil. When intermixed with clay, the vegetation is scanty, and consists chiefly of grasses. Clayey soil is indicated by the depressed and straggling nature of the vegetation, which consists chiefly of grasses of the genera Poa, Agrostis, and Festuca. By streams, a great profusion of Tussilago farfara generally indicates a clayey soil, and of T. petasites a deep rich vegetable soil. In the natural uncultivated state, vegetable soil is indicated, near the habitation of man, by Urtica dioica, Rumex obtusifolius, Artemisia vulgaris, Poa annua, P. pratensis, and Tanacetum vulgare, although nevertheless all these species may be found so situated in many varieties of soil; in pastures, by Trifolium repens, T. pratense, Poa annua, Plantago media, P. lanceolata, Vicia Cracca, Bellis perennis."

Rich alluvial soils recently deposited by the sides of low winding rivers are characterized, in their uncultivated state, by the growth of common reed, *Arundo phragmites*, round-headed rush, *Juncus conglomeratus*, white bent, *Agrostis alba*, reed meadow-grass, *Poa aquatica*, and floating meadow-grass, *Poa*

fluitans. When these soils have been drained and brought into cultivation, they are not infested by any of these five plants as weeds except *Arundo phragmites;* and they generally produce such luxuriant crops of corn as to be remarkably free from all sorts of weeds; but when they are indifferently farmed, they become distinguished by the presence of the corn thistle, *Cnicus arvensis.*—The clay soils which constitute the greater proportion of low carse lands are older and have been longer in a dry state than rich recent alluviums; and the plants which appear on them, in their natural state, are more numerous, and indicate the firmer texture of the ground. These are sweet briar, *Rosa rubiginosa,* common alder, *Alnus glutinosa,* common sallow, *Salix caprea,* common furze, *Ulex europæus,* meadow sweet, *Spirea ulmaria,* wild angelica, *Angelica sylvestris,* great spearwort, *Ranunculus lingua,* and common sorrel, *Rumex acetosa.* When such clay soils are subjected to cultivation, the shrubs and herbaceous plants are easily rooted out; and the weeds that appear are introduced either amongst the seed-grain or amongst the dung. These are, broad-leaved dock, *Rumex obtusifolius,* groundsel, *Senecio vulgaris,* nipplewort, *Lapsana communis,* cockle, *Agrostemma githago,* wild chamomile, *Matricaria chamomilla,* and common sow thistle, *Sonchus oleraceus.* The agrostemma and wild chamomile are introduced amongst the wheat and grass seeds, and maintain their ground among the subsequent crops.—The poorer clay soils, including the red or rock marl-clay, often found incumbent on red sandstone rocks, and those yellow ochry clays that are often met with in elevated situations, produce, in their natural state, the following perennial-rooted herbaceous plants,—knobby rooted figwort, *Scrophularia nodosa,* upright meadow crowfoot, *Ranunculus acris,* tufted hair-grass, *Aira cæspitosa,* corn horse-tail, *Equisetum arvense,* and marsh woundwort, *Stachys palustris.* When these soils are brought under tillage, the common colt's-foot, *Tussilago farfara,* grows amongst the corn crops, and is eradicated with difficulty when there is any calcareous sand mixed with the clay. The annual weeds, indicative of such clay soils, are, wild mustard, *Sinapis arvensis,* red eye-bright, *Bartsia odontites,* peach-wort, *Polygonum persicaria,* and knotgrass, *Polygonum aviculare.*—The natural productions peculiar to strong black loam, incumbent on whinstone or limestone rock, and reposing on a brownish open bottom above that rock, are bladder campion, *Silene inflata,* toad-flax, *Antirrhinum linaria,* field scabious, *Scabiosa arvensis,* great knapweed, *Centaurea scabiosa,* red shanks, *Polygonum amphibium,* and rough cock's-foot grass, *Dactylis glomerata.* When the rock is near the surface, the plants are, common rest harrow, *Ononis arvensis,* hare's-foot trefoil, *Trifolium arvense,* and hop trefoil, *Trifolium procumbens.* When soil of this nature is brought under tillage, the plants above enumerated gradually disappear. Under indifferent management, however, the *Polygonum amphibium* and *Ononis arvensis* are not readily extirpated. The plants found amongst the corns are, or ought to be, chiefly annuals, of which the following are the most characteristic,—scarlet pimpernel, *Anagallis arvensis,* ivy-leaved speedwell, *Veronica hederifolia,* needle chervil, *Scandix pecten-veneris,* black mustard, *Sinapis nigra,* and hairy tare or fetter, *Ervum hirsutum.* The four kinds of soil now enumerated, if they are met with within the 56° of north latitude, and under an elevation of 400 feet above the level of the sea, are capable of carrying wheat in perfection. The clays, if under an elevation of 300 feet, will produce excellent crops of beans with good management. Oats and barley may also form part of the rotation; but potatoes and turnips, except on the first and fourth kinds, are raised with difficulty. The fourth soil is seldom found at a high elevation, and is what farmers term 'land that carries a clod,' highly favourable for the culture of all sorts of corn and green crops.—Nearly allied to this is light black loam, on a clay subsoil, only it has a greater proportion of sand amongst the loam or vegetable matter, and less of clay or binding matter in its composition. The subsoil is also more various. Sometimes light black loam is found reposing on a clay or impervious 'till' bottom, spongy in the winter months, and apt to throw out plants by spring frosts. Many of the plants are found in soil of this nature that are to be met with on the poorer clays. The most predominant, when the soil is in a natural state, are, soft or common rush, *Juncus effusus,* sneezewort, *Achillea ptarmica,* wild tansy or silver-weed, *Potentilla anserina,* and mugwort, *Artemisia vulgaris.* The last continues some time after the ground is cultivated. The annual plants, indicative of this soil and subsoil, are, charlock, *Raphanus raphanistrum,* sheep's sorrel, *Rumex acetosella,* and corn marygold, *Chrysanthemum segetum.* In wet sandy furrows, and at the ends of ridges, toad-rush, *Juncus bufonius,* sometimes occurs. None of the above plants indicate great richness in the soil. Oats, barley, pease, potatoes, and turnips, succeed well on such soils, under favourable cultivation; and when there is a quantity of small stones on the surface, flax will be raised with advantage.—When light black loam is found on an open or gravelly subsoil, the plants most conspicuous are, common broom, *Genista scoparia,* common furze, *Ulex europæus,* black knap-weed, *Centaurea nigra,* yellow bed-straw, *Galium verum,* and common ragwort, *Senecio jacobea.* When, by cultivation, these plants are displaced they are followed by common corn mint, *Mentha arvensis,* blue bottle, *Centaurea cyanus,* corn madder, *Sherardia arvensis,* corn gromwell, *Lithospermum arvense,* parsley piert, *Alchemilla arvensis,* and tall knot-grass, *Avena elatior,*—which last is a troublesome perennial plant in light lands. The common corn thistle will also be found a troublesome intruder where the furze was formerly established. Where the above plants are found to predominate, corn crops of every description will succeed, if the climate is favourable. The soil may be found rather light for beans, and too open for wheat; but eating off turnips with sheep, and allowing the grass division to be two years under pasture, will improve the texture.—On sandy and gravelly soils, the broom, as a shrub, is found to predominate, particularly above freestone rock. Where the sand or gravel is of a calcareous nature, the whin acquires an establishment. The herbaceous plants peculiar to such soil are, bird's-foot trefoil, *Lotus corniculatus,* blue bell flower, *Campanula rotundifolia,* eye-bright, *Euphrasia officinalis,* sweet-scented spring grass, *Anthoxanthum odoratum,* and seaside sandwort, *Arenaria peploides.* When sandy soils in tillage receive too much of the harrow, the common spurry often destroys the growing crop. The common couch-grass, *Triticum repens,* is a troublesome plant, and requires close attention to the cleaning of drill crops to keep it under. The annual plants found amongst the corn, under proper cultivation, are, common spurry, *Spergula arvensis,* purple dead nettle, *Lamium purpureum,* common fumitory, *Fumaria officinalis,* shepherd's purse, *Thlaspi bursa-pastoris,* common knawel, *Scleranthus annuus,* thyme-leaved sandwort, *Arenaria serpyllifolia,* and common cudweed, *Gnaphalium germanicum.* Soil of this description is improved by lying long in pasture, and by eating turnips off it with sheep.—Moor may include heath-pastures in general, containing a considerable proportion of peat in the soil, with the subsoil exceedingly various, as indicated by the plants found. Many of the plants formerly mentioned are to be met with in low moors; and when the whin,

the ragwort, the *Lotus corniculatus*, the *Orobus tuberosus*, and the *Viola móntana*, are found to predominate in moor-grounds, though these plants are mixed with heath, the ground, if stones or steepness prevent not, may be improved by cultivation; but where the heath is found mixed with rein-deer moss, and the plants above specified absent, the soil and subsoil is sterile, and will not pay the expense of culture, and might be planted with the larch and Scotch fir to afford shelter and materials for fences to the neighbouring grounds. The following plants in moors indicate a wet retentive subsoil,—dwarf silky willow, *Salix repens*, butterwort, *Pinguicula vulgaris*, round-fruited carex, *Carex pilulifera*, moss-bush, *Juncus squarrosus*, scaly-stalked club-rush, *Scirpus cæspitosus*, Lancashire narthecium, *Narthecium ossifragum*, and grass of Parnassus, *Parnassia palustris*. On dry moors, containing a considerable proportion of peat earth, are, needle or petty whin, *Genista anglica*, mat-grass, *Nardus stricta*, yellow mountain violet, *Viola lutea*, common tormentil, *Tormentilla officinalis*, and mountain cudweed, *Gnaphalium dioicum*. — Marshy soils are found in their natural state to produce ragged robin, *Lychnis flos-cuculi*, fringed buckbean, *Menyanthes trifoliata*, marsh marygold, *Caltha palustris*, brook-lime, *Veronica beccabunga*, marsh cinquefoil, *Comarum palustre*, and marsh bed-straw, *Galium uliginosum*. And near the sea, sea arrow-grass, *Triglochin maritimum*, sea-marsh grass, *Poa procumbens*, pale carex, *Carex pallescens*, and great common carex, *Carex riparia*. When such marshes are dried, as they frequently contain a large proportion of decayed aquatic plants, they prove highly fertile, and few weeds appear after they are broken up. The most troublesome to farmers, are such as are introduced amongst seed grain, as goosegrass, *Galium aparine*. When the marsh is incumbent on marl, the common colt's-foot, *Tussilago farfara*, and the common butter bur, *Tussilago petasites*, are not easily rooted out. It may be remarked, that these plants are so partial to calcareous soils, as to form a signal to the natives of the lower valleys of Switzerland where to sink for marl.—Peat, or what is provincially termed moss, is often found without many plants covering the surface. Where the surface is dry, the cross-leaved heath, *Erica tetralix*, and the *Agrostis canina*, acquire an establishment. In the hollows are found, cotton grass, *Eriophorum polystachion*, and orange berry, *Vaccinium oxycoccus*. When moss is reduced to a state of cultivation by draining, the annual plants appearing are, soft brome grass, *Bromus mollis*, field scorpion grass, *Myosotis arvensis*, and wild oats, *Avena fatua*, and the *Galium aparine*, when its seeds are introduced amongst oats or barley seeds.—In the dens wholly inaccessible to the plough, and which are intended for plantations, the following plants, the natural productions of such dens, may assist in selecting suitable trees to the soil:—Where the great brake or fern, *Pteris aquilina*, is found in abundance, the oak will be found to succeed. The great wood rush, *Luzula maxima*, and the herb Paris, *Paris quadrifolia*, delight in tenacious soils, suitable to the hazel and the elm. The red campion, *Lychnis dioica*, the pilewort, *Ranunculus ficaria*, the dog's mercury, *Mercurialis perennis*, indicate a good soil for the maple and the ash. The wood anemone, *Anemone nemorum*, grows on a soil suitable to the birch. The water avens, *Geum rivale*, and the *Geranium pratense*, are found by the sides of rills, where the alder and Huntingdon willow will acquire a rapid growth.

The Improving of Soils.—The bringing of waste or barren lands into a state of cultivation is effected in various ways, according to the nature of the soil, the facilities of the situation, and the resources and objects of the reclaimer; and it is discussed in some of its most important bearings, in the articles Improvement of Land, Heath-Lands, Waste Lands, and Bogs. The ameliorating of the herbage and the increasing of the luxuriance of grass lands are accomplished by methods specially adapted to soil and circumstances; and are discussed in the articles Grass Lands, Meadow, Pasture, and Irrigation. The reclaiming and ameliorating of all sorts of wet lands, whether waste, grass, or arable, by the abduction of their excess of moisture, either along the surface or by taps or by subsoil ducts, are fully discussed in the article Draining. The neutralizing of acidity and of noxious oxides, the reduction of inert vegetable matter, the accelerating of the decomposition of stubborn organic manures, and the resolving and recombining of some mineral substances into available food for plants, by means of the well-known practice of liming, are discussed in the article Lime. The correcting of an excess of one chief mineral constituent by the intermixing of another, and the restoring or enriching of exhausted soils by the addition of plant-feeding substances in which they have become deficient, are discussed in the article Manure. The prompt removal of a great excess of coarse vegetable matter, or rather the prompt conversion of it into manurial principles, together with a concomitant ameliorating of the texture of the land which it has encumbered, is discussed in the article Paring and Burning. The artificial obtaining of an entirely new soil, in the form of a fresh deposit of alluvium, on low-lying lands, by the side and beneath the flood-level of rivers and estuaries, is discussed in the articles Colmata and Warping. The deepening of arable soils, the increasing of their porosity, and the renovating of their substance by means of additions or inversions from below, are discussed in the articles Trenching and Subsoil-Ploughing. The removing of foulness from arable lands, the accelerating of their mineral reduction, the full exposing of them to the chemical actions of the weather, and the seasonal subjecting of them to the completest possible course of tillage, are discussed in the article Fallow. And the ordinary and current conservation and increase of the fertility of arable lands, by the best routine practices of tillage and culture, are discussed in the articles Ploughing, Drill-Husbandry, Hoe, Horse-Hoe, Harrow, and Grubber, and in the articles on all the principal field crops.

The Cultivation of Soils.—Any soil, in order to be suitable for cultivation, or to possess the requisites of fertility, must contain all the mineral matters which yield the ashes of the plants destined to be cultivated upon it, in such a condition as to be available by the plants, and in sufficient quantity to enable the supply to be kept up by some economical mode of cultivation; it must consist of a due admixture of impalpable matter, and larger sized particles, so that it may be

porous and easily permeable by air and moisture, while, at the same time, there is a sufficient supply of matter in a state capable of undergoing chemical changes; and it must have mingled with it a sufficient supply of organic matter, in a state capable of decomposition by the action of air and water. To be fit for profitable cultivation, it must be free from any mineral substance which is destructive of fertility; it must be capable of being reduced to a sufficiently fine tilth, without an undue amount of labour; it must either be naturally capable of letting off any excess of water which may fall upon it, or capable of being made to do so artificially by draining; it must possess a structure which will allow the decomposition of organic matter mingled with it to proceed at a regular rate, being neither so fast as to waste the manure, nor so slow as to keep it too long fresh; and its situation must be such as to admit of all the operations of husbandry being performed in a proper manner, without occupying too much time, and must have a climate which shall give full promise of the plants arriving at perfection. To be capable of continued cropping, it must be ploughed and harrowed, and subjected to any other operations which may be necessary for thorough cleaning and pulverization; it must have its supply of organic matter, and part also of its mineral ingredients, renewed by returning to it from time to time in the shape of manure, what has been removed in the form of crops; and it must be kept in an active state, by having fermenting substances added to it at certain periods. And if it be in a bad or comparatively unproductive condition, then, in order to be freed from any great natural faults which hinder or impair its fertility, or to acquire such addition of new powers or increase of old ones as shall materially enhance its productiveness, or to recover the possession of any aggregate powers which it may have lost by overcropping or maltreatment, it must undergo either draining, liming, trenching, subsoil-ploughing, bare-fallowing, paring and burning, change of texture by intermixture of mineral manure, or whatever other of the operations mentioned in the preceding section, or of any two or more of them, may be best suited to improve it.

The comparative effects of vegetation upon soil in its natural or totally neglected condition, and in a condition of cultivation, may be stated as follows:—Uncultivated soil, however rich, becomes gradually less and less fertile, until it has attained the condition either of moor or marsh; it retains its luxuriance for the greatest length of time, when covered with forest trees and other large vegetables; it produces successive crops of different kinds, or, in other words, maintains a sort of natural rotation; when any species of plant on it disappears, its place is supplied by one of less value as an article of food, so that the richest pasture comes in time to produce only the coarsest and most worthless species of grass; and yet, though the natural produce of uncultivated soil thus uniformly decreases in value, the soil itself becomes progressively richer, so that, when brought under the plough, it will yield much larger returns than could be expected from its spontaneous produce. Soil which is regularly cultivated or continually ploughed yields its nourishment in much greater abundance, and with greater ease, to plants growing upon its surface; the facility with which the productive powers of well cultivated land are diminished, depends on its organized matter being more easily converted into compounds soluble in air and water; the decrease of fertility in carelessly cultivated soil depends, in addition to the above circumstance, upon a diminution in the proportion of its impalpable matter; cultivated land, when properly taken care of, becomes gradually richer and richer, notwithstanding the increased quantity of produce annually removed from it; if the same plant be cultivated for several years successively upon the same spot, the soil much more rapidly decreases in fertility than when a variety is kept up; and some of the most valuable mineral constituents of soil decrease in greater rapidity in proportion to the greater care bestowed upon its cultivation, altogether independent of the portions removed by the crops.

The particular principles involved in the successful cultivation of the numerous and widely different kinds of field crops, may, in a main degree, be deduced by intelligent farmers from the five following facts:—1. All plants require a good supply of nourishment during the first periods of their growth, for without this they will never arrive at perfection. If, therefore, nature has not provided a stock of nourishment laid up in the seed, it must be supplied artificially. Seeds, therefore, which are devoid of this natural supply of food, must be provided with an abundance of well fermented manure, unless it is required that the first stages of their development should occupy a considerable period of time. 2. Many plants have more than one method of propagating themselves; if, therefore, one method is more desired than another, means should be used to prevent the others from being accomplished, as by preventing the one, you increase the vigour of the other. 3. Plants lay up a store of nourishment for the next year, either in the wood, as in perennials, or in the seeds, as in annuals. 4. The starch of plants is always contained in cells, formed of a substance containing azote; and, consequently, there exists a fixed proportion between the quantity of azote composing the cells, and the amount of starch contained in them; hence it follows, that to increase the quantity of starch in a plant, you must increase its supply of azote, although starch itself contains no trace of this element. 5. In all parts of a plant there is an exact proportion between the various elements entering into its composition, so that an addition to one of them

is necessarily followed by a relative addition to them all. If, for example, a plant possesses one part containing 2 grains of azote, combined with 18 grains of other elements, and another portion containing 2 grains of azote, combined with 48 grains of other elements; if we, by any means, prevent the development of the more highly azotised portion, viz., the 2 to 18, we shall produce a proportional increase in the other; so that, by preventing the formation of 20 grains of the highly azotised portion, we obtain 50 grains of that which contains proportionally less azote.

The Analysis of Soils.—The meanings of the word analysis, a brief general view of the importance of the analysis of soils, and a detailed account of the principles of all chemical analysis, are given in the article ANALYSIS; and a number of statements and discussions which have a strong bearing on questions as to the methods and uses of analysis of soils occur in the articles MANURE, FARM-YARD MANURE, GUANO, FOOD OF PLANTS, and many others. The analysing of soils affords more certain and more valuable information respecting them than any other mode of investigation, and is essential for opening a balance-account between the withdrawal of substances by crops and the adding of them in manures, and forms a chief means of reducing the general doctrines and discoveries of agricultural chemistry to beneficial practice, and in general serves as a mighty appliance for carrying forward in the world, and fixing down on individual farms, the great and growing agricultural intelligence of the age. Two kinds of it may be practised, the mechanical and the chemical; and excellent methods of these—the mechanical by the Rev. W. L. Rham, and the chemical by Dr. Ure—have been published in the Journals of the Royal Agricultural Society, and shall here be transcribed.

"The soil to be examined must be taken a few inches under the surface, and in different parts of a field. If there appears much uniformity, the portions may be mixed, in order to have the average quality of the soil: should there be a visible difference between one portion and another, which is often the case, each may be analysed separately. A portion of the earth to be analysed is dried in the sun or near a fire, until it feels quite dry in the hand. It is then reduced to powder by the fingers, or by rolling it on a deal board with a wooden roller, so as to separate the particles, but not to grind them: any small stones above the size of a pea must be taken out. If these form a considerable part of the soil, their proportion must be ascertained by weight; their nature and quality may be afterwards examined. This, being a very simple operation, and obvious to the sight, need not be described. Where the stones and pebbles are evidently accidental, they may be overlooked, as having little influence on the fertility. The dry earth, cleared from stones, should be accurately weighed; and it is convenient to take some determined quantity of grains, as 1,000, 500, or 250, according to the accuracy of the instruments at hand. This portion should be put into a shallow earthen or metal vessel, and heated over the fire, or a lamp, for about ten minutes, stirring it with a chip of dry wood: the heat should not be so great as to discolour the wood. It may then be allowed to cool, and be weighed again; the loss of weight indicates the water which remained uncombined after the soil appeared quite dry. This is the first thing to be noted. The power of retaining water, without any external appearance of moisture, is greatest in humus, next in clay, both of which readily absorb it from the atmosphere; carbonate of lime does so in a less degree, and siliceous sand least of all. This moisture occupies the pores of the soil, and is very different from the water which is combined with clay as a part of its substance, and to which it owes its ductility; for when this last is expelled by a great heat, the clay loses its quality, and approaches to the nature of sand. Pounded brick will not bind with water; and porcelain reduced to a fine powder has all the properties of siliceous sand in the soil. The finer the division of the particles of the soil, the greater will be its power of absorbing and retaining water; but in a soil where clay greatly predominates, the lumps sometimes become so hard and baked by the sun that the moisture cannot penetrate, and in this case the power of absorption is much diminished. Hence loams in which there is a good proportion of humus have a greater power of absorption than the pure earths. Taking all circumstances into consideration, it will be found that the soils which most readily absorb moisture are also the most fertile, and therefore it is important to ascertain their power of absorption. This can be found by comparison. Equal portions of different soils, dried as before, are placed in the opposite scales of a good balance, and left exposed for some time to a moist atmosphere. That which preponderates has the greatest power of absorption; the degree is measured by the difference of the acquired weights.

"Another important circumstance is the specific gravity of a soil. The different earths have very different specific gravities; and humus being lighter than any mineral earth, the lightness of the soil is a sure indication of its richness, excepting where this lightness is occasioned by an excess of undecomposed vegetable matter, or peat. Humus, when nearly pure, has a specific gravity varying from 1·2 to 1·5; fine porcelain-clay, 2; chalk, about 2·3; siliceous sand from 2·5 to 2·7. Mixed soils have specific gravities varying according to the proportions of their component parts. Those in which clay, chalk, and humus abound, and which are generally the most fertile, are the lightest. The sandy soils are heavier, and the more so if they contain oxides of iron or of other metals; and it is well known that the ferruginous sands are the most barren. The common expression of *light*, when applied to a sandy soil, has no reference to its specific gravity, but merely to the force required to plough it. No carrier would say that a loose sandy road was a light one. The easiest and readiest method of determining the specific gravity of earth, or any substance which is of a loose texture, is that described by Dr. Ure in his Philosophy of Manufactures (page 97), as employed by him to ascertain the specific gravities of cotton, wool, silk, and flax. It is as follows:—Take a narrow-necked phial capable of holding four or five ounces of water; mark a line round the middle of the neck with the point of a diamond or a file; fill the phial up to the mark with river or rain water, and poise it with sand or any other substance in a scale; then put 1,000 grains' weight in the same scale with the phial, and pour out water till the equilibrium is restored. In the vacant space, which is evidently equal to the bulk of 1,000 grains of water, introduce the soil till the water rises to the mark in the neck. Then put into the opposite scale grain weights sufficient to restore the equilibrium. The number of grains required for this purpose will

denote the specific gravity of the soil compared to water as 1,000. Suppose, for example, that siliceous sand, which is 2·7 times denser than water, is poured into the vacant space, it will require 2,700 grains to fill the space occupied by the 1,000 grains of water; and thus we have the specific gravity without any calculation. If instead of 1,000 grains, we use only 500, or 250, the result will be the same, if we multiply the grains in the other scale by 2 or 4. We will give a few examples of soils of which the specific gravity has been carefully determined.

A rich garden soil, which contained per cent.,

Clay	52·4
Siliceous Sand	36·5
Calcareous Sand	1·8
Carbonate of Lime	2·0
Humus	7·3

had a specific gravity of 2·332.

A good loam, consisting of

Clay	51·2
Siliceous Sand	42 7
Calcareous Sand	0·4
Carbonate of Lime	2·3
Humus	3·4

had a specific gravity of 2·401.

A poorer soil, of which the component parts were

Siliceous Sand	64·0
Clay	32·3
Calcareous Sand	1·2
Carbonate of Lime	1·2
Humus	1·3

had a specific gravity of 2·526. These examples suffice to show that the specific gravity of a soil is some tolerable indication of its fertility. It cannot, however, be entirely relied upon in the absence of other proofs; for there may be many different mixtures of earths which will have the same specific gravity, although they may differ greatly in their fertility; but it will facilitate the analysis, and often detect mistakes in the process, if the result does not accord with the specific gravity found.

"We proceed now to the analysis. The portion of soil which has been deprived of all its water, as described above, must be sifted through metallic sieves of different fineness. The first is made of a perforated tin plate, the holes of which are about one-twentieth of an inch in diameter. Whatever does not go through this is put by. The remainder is successively passed through two or three more sieves, increasing in fineness to the last, which is of the finest wire-cloth, having from 150 to 170 threads in an inch: whatever passes through this is impalpable powder. Thus we have already a division of the soil according to the size of its particles:—1st, the coarse grit left in the first sieve; 2d, the finer grit in No. 2; 3d, fine sand in No. 3; and 4th, impalpable powder, which has passed through the last sieve. To facilitate this part of the operation the sieves may be made so as to fit into one another, like the filterers in a coffee-biggin, the last fitting into a tin pot which will hold about a pint of water: a cover being made to fit on the top sieve, the instrument is complete. (See *Fig.*) Thus all the sifting may be done at once, without any loss. Any lumps which are not thoroughly pulverised must be broken. The coarser sand left in the sieve No. 1 must now be washed with pure water to detach any fine dust adhering to it; what runs through may be used to wash No. 2, in the same manner, and then may pass through No. 3 to the impalpable matter which passed through all the sieves. A sufficient quantity of water must be used to render the whole of this last nearly fluid. There will then be three different portions of the washed soil left in the sieves, and a portion of impalpable matter diffused through the water in the lower division of the instrument. This last is the principal object of analysis, and that to which Sir Humphrey Davy usually confined his attention, merely noticing the proportion of coarser sand in the soil. It contains, no doubt, the great principle of fertility and nutrition; and the effect of the coarser parts may be considered as chiefly mechanical. But they may much affect the fertility of the finer parts, and are of the greatest importance to the soil in which they are blended: they consequently deserve a more minute examination, to which we will return. In the mean time our attention shall be directed to the composition of the finer earth in No. 4, which is mixed with water in a semi-fluid state. This is well shaken, and suddenly poured into a deep glass vessel, and allowed to settle for a few minutes, when the heavier earth, which is sand, will be deposited, and the lighter may be poured off suspended in the water. It requires some little practice to effect this at once, but a few trials will soon enable any one to do it. This operation may be repeated until all the sand, of which the particles are visible to the naked eye, is separated. The earth and water decanted out of this last vessel are now poured into a glass tube, 18 inches long (No. 1), the bore of which is less than an inch: one end is stopped with a cork fitted into it, and the other has a small lip for the convenience of pouring out the contents. In a short time there will be a further deposition of earth, which will be principally alumina. What remains suspended in the water over it is gently poured off into another similar tube (No. 2): this will contain nearly the whole of the humus, which will take some hours to be deposited in the form of a fine brown mud. The contents of the tube No. 1 may now have a little more water added to them; after being well shaken, the tube may be set upright, and left for half an hour to settle: what remains suspended in the water after this must be added to the humus in the tube No. 2. After some time this will also be deposited; and the clear water may be decanted off. The mud which remains is put on filtering-paper in a glass funnel, and, when all the water has drained from it, it is dried over the fire, and weighed. This is the most important portion of the soil. The fine earths deposited in the tube No. 1 will consist of very fine particles of sand, clay, and perhaps carbonate of lime. The sand will appear deposited in the bottom of the tube. The clay may be easily diffused in the water above it by stirring it carefully with a small rod without reaching the sand. It may then be decanted off with the water into another tube (No. 3), and allowed to settle: this part of the operation may be carried to a great degree of perfection by great care, and by examining the results occasionally with a small microscope; but for all common practical purposes, it is sufficient to separate the vegetable earth from the mineral, and the visible particles of sand from the finer. The contents of No. 1 having been collected, as well as those of No. 3, are dried over the fire and accurately weighed. The same is done with the earths which remain on the sieves. All the water in which the earths have been diffused and washed is collected and passed through filtering-paper, and then set over the fire in a common saucepan. It is boiled away gently until it is reduced to a small portion, which begins to look turbid. The complete evaporation is finished in an evaporating dish, as slowly as possible, and the residue is the soluble matter contained in the soil. It will be sufficient to dry and weigh this, as its further analysis would require more skill and chemical knowledge

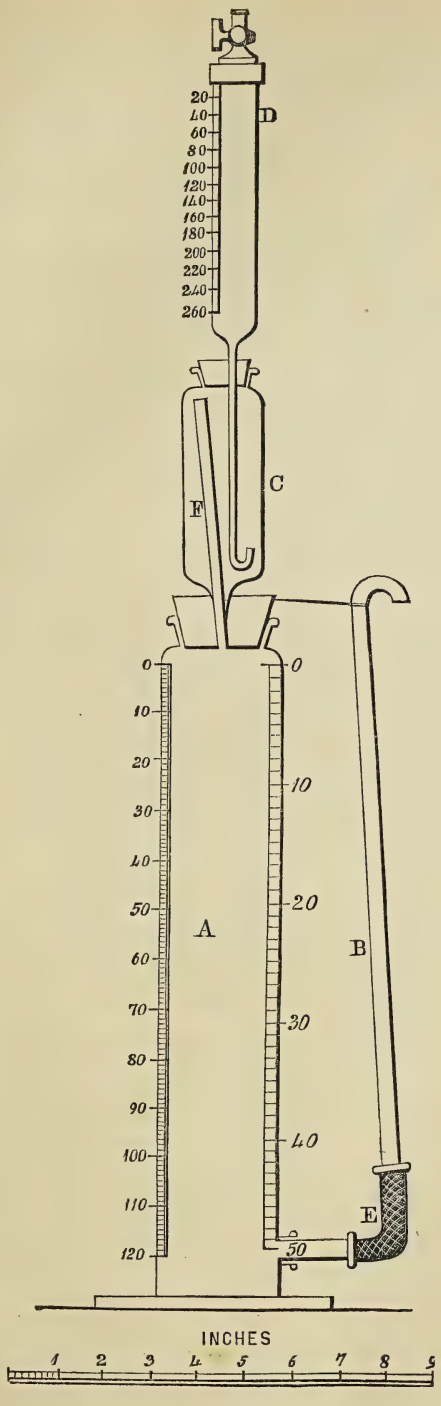
than we suppose in the operator. Salts may be detected by the taste, or by the crystals formed in the evaporation; but, unless there is a decided saline taste, the whole may be considered as soluble humus, and the immediate fertility of the soil depends greatly on the quantity of it. To recapitulate what has been obtained, — we shall have the coarse grit in sieve No. 1; the sand in Nos. 2 and 3; the fine earth separated in the tubes Nos. 1 and 3; the humus in tube No. 2 and on the filtering-paper; and the soluble parts in the evaporating-dish. All these substances must be well dried over the fire, as was done with the soil at first, and each separate part accurately weighed. The sum of them ought to be equal to the original portion of soil subjected to analysis after the water was driven off; but there always is a loss, even with the most experienced analyser. This loss will be principally in the finer parts, which are dissipated in the operation.

"But the analysis is not yet completed: we have separated the sand, clay, and humus; but there may be a portion of carbonate of lime, in the form of sand, or of finely-divided earth mixed with the other earths. To ascertain this, each portion, excepting the humus, is put into a separate cup, and a little muriatic acid, diluted with four times its weight of water, is poured on it. If there is any effervescence, it shows the presence of carbonate of lime; diluted acid is then added gradually, as long as the effervescence is renewed by the addition. When this ceases, and the water continues to have an acid taste, more pure water is added, and each portion separately filtered, dried, and weighed. The loss of weight in each gives the quantities of carbonate of lime dissolved by the muriatic acid, and which has passed with the water in the form of muriate of lime.* The different weights being now collected, the result of the operations might be set down. There may be many mineral substances in the soil which this mode of analysing will not detect; and some of these may materially affect the fertility. In most cases there will be something to indicate the presence of metals. Iron abounds in most soils: when the quantity is considerable, it will be detected by pouring a decoction of gall-nuts into the water which has washed the earth; it will immediately become of a bluish dark colour. The other metals are not of frequent occurrence. Sulphate of lime or gypsum, and also magnesia, are found in some soils; but the separation of them can only be effected by those who are well acquainted with chemistry: they fortunately occur very seldom, and the places where they are found are generally well known. For all practical purposes, it is sufficient to ascertain the proportion of sand, clay, carbonate of lime, and humus which any soil contains. Many soils which have been highly manured contain portions of undecomposed vegetable substances, and fibres of roots; these will be found mixed with the coarser earths separated by the sifting: not being a part of the natural soil, they need not be taken into the account; but they may be separated by washing the earths, as they are much lighter, and will come over in the first decantations. They may be dried and weighed, and the quantity set down in the result, if it is desirable. Some very barren sands, containing very little argillaceous earth or humus, may readily be known by the copious sandy deposit which they rapidly make when diffused through water. Good natural loams are not so easily judged of; but the preceding mode of analysis will in general detect their intrinsic value. When a soil contains peaty matter, it is easily discovered by the irregular black particles which are visible in it. Peat differs from humus only in being in a different state of decomposition, and containing a considerable portion of tannin; when acted upon by lime or alkalies, and brought into a state of greater decomposition, it is not to be distinguished from humus in its qualities.

"The process which we have described, simple as it is, may yet be too tedious for the farmer who is desirous of speedily comparing different soils; and we will indicate a still simpler method of ascertaining, nearly, the composition of a soil and a simple instrument by which it may be done. Take a glass tube, $\frac{3}{4}$ of an inch in internal diameter, and 3 feet long; fit a cork into one end, and set it upright; fill it half full of pure water; take nearly as much water as has been poured into the tube; and mix with it the portion of soil which is to be examined, in quantity not more than will occupy 6 inches of the tube; pour the mixture rapidly into the tube, and let it stand in a corner of a room, or supported upright in any way. In half-an-hour it may be examined. The earths will have been deposited according to the size and specific gravity of their particles. The portion still suspended in the water may be allowed to settle; and there will appear in the tube layers of sand, clay, and humus, which may be measured by a scale, and thus the proportions nearly ascertained. When a farmer is about to hire a farm, of which the quality is not well known to him, he may be much assisted in his judgment by this simple experiment, if he has no time or opportunity for a more accurate analysis. For the glass tube may be substituted one of tin or zinc 2 feet in length, with a piece of glass tube, a foot long, joined to it by means of a brass collar or ferule with a screw cut in it, which is cemented to the glass, and screws on the metal tube; and thus the instrument may be made more portable. When the water has been poured off, and the earths only remain, the cork may be taken out, and the contents pushed out on a plate, by means of a rod and a plug which exactly fits the internal diameter of the tube. They may thus be more particularly examined."

"The first problem in an agricultural analysis," says Dr. Ure, "is to find the proportion of calcareous matter, as carbonate and phosphate of lime. This may be easily solved with the aid of the instrument figured below, which may be called the Limestone Meter. A, is a cylinder of glass, two inches in diameter, and fourteen inches long, graduated on one side with a scale, into spaces of 100 water-grain measures from 0 to 12,000, marked 10, 20, 30, &c.; and graduated on the other side into spaces of 240 water-grain measure, each. The former scale is used for the analysis of all sorts of alkaline carbonates, and also of acids; the latter is adapted to the direct analysis of carbonate of lime and marls, and indirectly to that of phosphate of lime and carbonate of magnesia. The cylinder A, has a tubulure in its side near to the bottom; this is closed with a cork, in the axis of which a short glass tube is cemented, hooped externally to a collar of caoutchouc E, which serves as a joint to the upright long glass tube B, held near its upper recurved end in a hooked wire. The top of the cylinder A is closed with an elastic cork, through a perforation in which the taper tail of the little phial C passes air-tight. The small tube F, open at both its ends, is cemented on its outer surface, into the bottom of the phial C, so as to close it, while the tube itself opens a free passage to gas, from the shoulder of the phial, down into the cylinder A. The mouth of the phial C is shut with a cork, through which the small end of the tube D passes air-tight. The tube D is graduated into spaces of 10, 20, &c., water-grain mea-

* It may be objected to this mode of ascertaining the carbonate of lime, that the muriatic acid will dissolve iron, and a portion, however small, of alumina as well as carbonate of lime, and that the collecting the carbonic acid evolved is a more exact measure of the quantities of the carbonate. This may be admitted; but we repeat that we only propose a simple and easy analysis, which will approximate to the truth, and not by any means a perfect one.



sures up to 250, and is closed at top with a stop-cock. Its lower and capillary extremity is recurved. In ascertaining with this instrument the proportion of real carbonate of lime, in any limestone, marl, or soil, proceed as follows:—Lift out the phial C, and pour water into the cylinder A till it stands about half an inch below the line marked 0, and fill up this space with common linseed-oil. Restore the phial C to its place, pressing it in air-tight. Then take out its cork with its graduated tube, and introduce into the phial as many grains' weight of the soil or marl as it is proper to operate upon. Of an average limestone 50 grains are sufficient, because the magnified scale of the *lime-proof* is adapted to the analysis of 50 grains of pure carbonate of lime. Of soils and marls, 100, 200, or even 500 grains, may be taken, because these substances will rarely contain one-tenth their weight of carbonate of lime. But as the result may always be obtained within five minutes, at the cost of half a farthing, several successive experiments may be made on different weights of the sample. Having introduced the proper weight of the object into the phial, cover it with water, till this stands a little above the point to which the recurved tube descends. Holding D in the hand, dip its bent point into a phial containing ordinary muriatic (hydrochloric) acid, diluted with its own bulk of water, and applying the mouth to the opened stop-cock, suck up the acid into the tube till this be about two-thirds full, then turn the key of the cock before it is taken from the lips, and the acid will not drop out when the tube is held upright. Replace the cork with its tube D in the phial C. Detach the long tube, B, from its wire-rest with the left hand, and hold its curved extremity above an empty basin; then with the right hand open the stop-cock of D, to let a little acid run down upon the marl, but shut it almost instantly again, lest too much acid should escape, and cause so brisk an effervescence as to occasion an overflow of the mixture into the small tube, F. The disengaged carbonic acid escapes through the tube F, presses on the surface of the oil in A, and causes a stream of water to flow from the tube B, into the subjacent basin. When the water ceases to run, open the stop-cock again, when more acid will descend, cause a fresh extrication of gas, and a further flow of water. The curved end of the tube B should be progressively lowered, as the oil falls in A, so as to maintain its level and that in the tube in the same horizontal plane. Whenever gas ceases to be extricated by the muriatic acid, the experiment is completed, and the number on the *lime-meter* scale opposite to the upper surface of the oil, denotes the number of grains of carbonate of lime, in the quantity of limestone, marl, or soil, put into the phial C for experiment. A little carbonic acid gas remains condensed in the muriatic solution, but this is not more than equivalent to the bulk of liquid acid introduced into the capacity of the apparatus; so that no compensation need be made in this account. For the purpose of minute chemical research, that portion of gas may be expelled by surrounding the phial C with a cloth wrung out of hot water, and the volume of dilute acid added, may also be taken into the account. Thus the composition of carbonates by an acid, and of acids by a bicarbonate, may be determined by means of this instrument with equal rapidity and precision. The contents of the phial may be poured out into a porcelain capsule, gently heated, and thrown on a filter. The lime of the carbonate, as well as the phosphate of lime and the magnesia, will pass through in solution along with a very little iron. On super-saturating the acidulous liquor with water of pure ammonia, phosphate of lime (if present) will fall, and may be drained on a filter and dried. Taken off the dried filter, and digested with a little dilute sulphuric acid, sulphate of lime will result, characterized by its entire insolubility in dilute alcohol. Hence the sulphate washed with vinous spirits, dried and calcined, will represent by its weight one-fifth more than the original weight of the phosphate. By the action of the sulphuric acid, the iron precipitated by the ammonia with the phosphate is got rid of. The magnesia, unless its proportion had been very great, will all remain dis-

solved as ammonia-muriate, and its quantity may be ascertained by precipitating it either with soda or phosphate of soda. In the former case, the substance obtained when washed on a filter, dried and ignited, is pure magnesia; in the latter, it is the ammonia-phosphate of magnesia, and when dried at the moderate heat of 120° Fahr., it represents by its weight about six times of the magnesia present; or for 100 parts, 16½ of magnesia.

"When a complete analysis of a soil is to be made, the following apparatus is convenient:—A large glass flask, or matrass, with a sucked-in or concave thin bottom. This should hold at least a quart of water; and when the soil and dilute acid are introduced, it is to be placed on a stand over the gentle flame of a spirit lamp, while the beak of a large glass funnel, having its mouth covered with a porcelain basin, filled with cold water, is inserted into the neck of a flask. By this arrangement, a continual ebullition may be maintained in the mixture of soil and acid, without loss of acid, or nuisance from its fumes, because the vapours are condensed whenever they reach the cold basin above the funnel, and a perpetual cohobation takes place. A boiling heat may be kept up in this way till every constituent of the soil, except the silica, becomes dissolved. Muriatic acid is generally preferred for the analysis of soils, and in somewhat greater quantity than the bases in the given weight of soil can neutralise. The funnel and porcelain basin should be properly supported upon the rings of the chemical stand. I generally subject 100 grains of soil to the action of boiling dilute acid in this way for 6 or 8 hours; at the end of that period, I throw the contents of the matrass upon a filter, and super-saturate the filtered liquid with ammonia. The silica which remains on the filter having been washed in the process, is dried, ignited, and weighed. The alumina, iron-oxide, and phosphate of lime, thrown down by the ammonia, being washed in the filter, and dried to a cheesy consistence, are removed with a bone or tortoise-shell blade into a silver basin, and digested with heat in a solution of pure potash, whereby the alumina is dissolved, when its alkaline solution is to be passed through a filter, then saturated with muriatic acid, and next super-saturated with ammonia. Pure white alumina falls, which is to be separated on a filter, washed, dried, ignited, and weighed. The iron and phosphate of lime on the alkaline filter may be dried, gently ignited, and weighed, or otherwise directly separated from each other without that step, by the action of dilute alcohol, acidulated with sulphuric acid, at a gentle heat. Thus the iron-oxide will be dissolved, and its solution may be passed through a filter, while the sulphate of lime will remain upon it, to be dried, ignited, and weighed. Five parts of it correspond to four of phosphate. The iron is obtained by precipitation with water of ammonia, filtration, and ignition. The first filtered liquor, with excess of ammonia, contains the lime of the carbonate, and the magnesia. The former is separated by a solution of oxalate of ammonia, with digestion in a gentle warmth for a few hours, filtration, and very gentle ignition of the washed dry powder, when the pure carbonate of lime is obtained. The magnesia, existing in the filtered liquor as an ammonia-muriate, may be obtained by precipitation with soda, or phosphate of soda, as already described. For some refractory soils, in which the alumina exists as a double or triple silicate, it becomes necessary to fuse 50 grains of the sample, in fine powder, mixed with four times its weight of dry carbonate of soda, the mixture being put into a platinum crucible, and into a cavity in its centre, 50 grains of hydrate of potash being laid. The crucible being slowly raised to a red-white heat, affords a fused liquid quite homogeneous, of a grey or brown colour, according to the metals present in it. Manganese gives a purple tint; and iron a reddish brown. The fused matter should be poured out into a shallow platinum basin; and, whenever it cools, it should be pulverized, dissolved in dilute muriatic acid, the solution evaporated to dryness, the dry mass again digested in hot water, acidulated with muriatic acid, and the whole thrown upon a filter. Pure silica will remain on the filter, to be washed, dried, ignited, and weighed. The filtered liquor contains the remaining constituents of the soil, and is to be treated as already described.

"Besides these systematic investigations, researches may be made for certain peculiar substances, and especially the neutro-saline constituents. In this view 100 grains of the soil may be triturated with 20 times their weight of distilled water, placed in a beaker, till the clayey matter subsides, and the clear portion then be decanted into a filter. A little of the filtered liquor should be tested with nitrate of barytes, and also with oxalate of ammonia; and if each portion yields a precipitate, they show the presence of sulphate of lime; and the following steps ought to be taken to eliminate it entirely: 200 grains of the soil should be triturated with a quart of distilled water, holding 50 grains of sal-ammoniac, in solution. The mixture should be allowed to clarify itself by subsidence, when the supernatant clear liquor should be filtered, and evaporated down to 2 ounce measures, and then mixed with that bulk of strong whisky (11 per cent. overproof). The whole sulphate of lime will be now separated from the fluid, and after being drained on a filter, may be dried, ignited, and weighed. For determining the alkaline salts, the water filtered from the 100 grains of the soil should be evaporated down to one-fifth of its bulk, and then treated—1st, with nitrate of barytes for the sulphates; 2d, with nitrate of silver for the muriates; 3d, with oxalate of ammonia, for the nitrate or muriate of lime (provided no sulphate of lime is indicated by the first test); 4th, with litmus paper, for alkaline or acid reaction; 5th, with soda-chloride of platinum for potash salts, which are very valuable for the vigorous growth of many plants. The portion of soil tested for potash salts should, before being digested in water, be gently calcined, to insure the expulsion of every particle of ammoniacal salt, otherwise the precipitate afforded by soda-chloride of platinum would be fallacious.

"Another peculiar research of great importance is that which determines the amount of ammonia in a soil; and which may exist either ready formed, or in its elements, capable of affording a portion of the azotic food so indispensable to vigorous vegetation. The actual ammonia is easily obtained by distilling the soil along with some milk of lime. The distilled water will contain all the volatile alkali, which may be measured by the number of drops of a standard dilute acid, which it will saturate. The potential ammonia, slumbering, so to speak, in its embryo elements, may be estimated by igniting 200 grains of the soil with its own weight of a mixture of hydrate of soda and quicklime.

"Since the phosphates are such precious ingredients towards fertilizing soils, it is desirable to possess a clear and simple test of their presence. For this purpose, digest the soil, for an hour or so, with a moderate heat, in dilute nitric acid, free from muriatic (viz. which affords, when largely diluted, no precipitate, by the addition of a solution of nitrate of silver). Throw the mixture on a filter, and to the filtered liquid add potash-water, cautiously, till the instant that a precipitate begins to appear; then drop into it a weak solution of nitrate of silver. If any phosphoric salts be present, a yellowish precipitate will immediately fall, which is re-soluble in

an excess of nitric acid. Whatever is not thus dissolved is chloride of silver, and ought to be separated by filtration: on adding then weak water of potash (not ammonia) cautiously to the filtered liquid, the pure phosphate of silver will be obtained, without any alumina or iron, provided the liquid be still acidulous in a slight degree. It ought to be remembered that chloride of silver falls in a *white* curdy form, quite different from that of the phosphate of silver. The portion of soil used for this experiment should be fresh, and not calcined, because the *phosphates*, when ignited, afford white precipitates with salts of silver. The stronger the solution of the phosphoric saline compound is, the more characteristic is the yellow precipitate with silver; and then ammonia may be used for effecting the partial saturation of the acid excess. Sulphate of magnesia is an excellent re-agent for detecting phosphoric acid, and for separating it from the above acid solution, when it is partially neutralized with ammonia; for the magnesia forms, with the phosphoric acid and ammonia, the insoluble granular precipitate of ammonia-magnesian phosphate. A solution of sulphate of magnesia, containing a little sal-ammoniac, is probably the best test-liquor for detecting phosphates in faintly acidulous, but still better in neutral, solutions. In almost all soils of an arable nature under cultivation in this country, there is a sufficiency of calcareous matter present to counteract the combination of phosphoric acid with alumina or oxide of iron, for which reason it would be an idle refinement of agricultural analysis to search for phosphates of alumina and iron. As for manganese, often associated with iron, it exists in too small a proportion, and is possessed of too little value to make it worth while to effect its separation. It gives to calcined iron-oxide a black hue, and is characterized in its saline solutions by the flesh-coloured precipitate which it affords with hydro-sulphuret of ammonia, after the whole of the iron has been thrown down by boiling the solution of the two metals with pure carbonate of lime.

"The organic matter in any soil may be correctly estimated by calcining its powder pretty strongly till the carbonic acid be expelled from the lime in it. The loss of weight, deducting that due to the carbonic acid gas (which is known from an independent experiment), gives the quantity of organic matter. Its quality is determined by the ultimate analysis by means of hydrate of soda and quicklime, as previously stated."

Lyell's Principles of Geology.—De La Beche's Geology.—Philip's Geology.—Johnston's Lectures on Agricultural Chemistry.—Davy's Agricultural Chemistry by Shier.—Liebig's Chemistry of Agriculture.— Chaptal's Chemistry of Agriculture.—Annals of Agriculture.—Communications to the Board of Agriculture.—Young's Farmer's Guide.—Goodrich Smith's Economy of Farming.—Dr. Dickson's System of Practical Agriculture.—Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.— Potts's Farmer's Cyclopedia.—Hunter's Georgical Essays.—Sproule's Treatise on Agriculture.—Buel's Farmer's Instructor.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.

SOILING. The feeding of live stock in summer with green food, cut daily, and given to them in houses, stalls, or yards. It is not suitable for young or growing animals, who require a moderate degree of exercise in the fields in order to the maintaining of health and vigour,—nor for most of the live stock of farms which are so extensive that the daily carrying of the green food from the comparatively distant fields would involve too great an expense; but it is well suited for the final feeding of cattle on all sufficiently convenient farms,—for the ordinary feeding of working horses and working oxen, whose time is too valuable to allow of their slowly grazing in the field,—for the feeding of hogs and other minor stock, who do harm by roaming abroad,—and for the feeding of milch cows on all small country farms, town dairy farms, and cottier's plots or allotments. "It is not very generally adopted in British husbandry," says Mr. Rham, "it being so much easier to allow the cattle to crop their food in the pastures; but in those countries where property in land is greatly subdivided, and where farms are small and good pasture scarce, as in Flanders, France, and Switzerland, especially where the vineyards render manure scarce and dear by taking a considerable portion of it and returning none, there the soiling of cattle is almost a matter of necessity. A cow or ox requires from two to three acres of pasture or meadow to feed it all the year round, allowing a portion for hay. But by raising clover, lucern, sainfoin, tares, and other green crops, three cows or more can be fed with the produce of one acre, especially if a portion is in turnips or other succulent roots. Thus the straw of the white crops is converted into excellent manure, and the land kept in a state of fertility." The system is admirably adapted to the existing state of the greater part of Ireland, and, if generally adopted, would materially assist to relieve the prevailing penury of the small farmers of that country; and it is also well suited to many middle-sized and even large farms in all parts of Britain, where the supplies of manure are scanty or costly, or where the circumstances of soil and situation would produce the highest profit from a maximum growth of corn,—and it could be sufficiently well accommodated to the carrying conveniences of any extensive farm to which it is otherwise eminently suitable, by the erection of houses or sheds for the cattle in different and mutually distant localities.

One advantage of soiling, is the addition to the health, strength, and secretions or flesh of the animals, resulting from regularity and fulness of feeding, from the absence of all interruption and inconvenience in feeding, and from superior protection from the heat of the sun and the harassing attacks of flies.—Another advantage is the economising of food, by the prevention of waste in the use of it, by the growing of kinds which are far bulkier and more nourishing than any crops of grass, and by the saving of land for the production of the costlier sorts of food suitable for the use of man. Any given superficies of land has been proved, by many, various, and careful experiments, to feed from two to five or six times more cattle in the soiling

method than in the depasturing one; and probably no one piece, if wisely managed, would ever do less than feed at least three or four times more, while many a piece might feed so much as seven or eight times. Waste often occurs also in the soiling method, indeed, by portions of leguminous crops getting into pod before being cut, by portions running into over-ripeness and decay, and by some part of the cut and carried supplies being trodden down or heated; but these modes of waste, as well as all others incidental to soiling, may easily be avoided by methodical proportioning of the different kinds of green crop, by timeously cutting down the excess of each for hay, and by proper system in the daily carrying and feeding; while the methods of waste and loss incidental to depasturing—such as the trampling down of the herbage, the defouling of it with excrements, and the total occupation of the land with it to the exclusion of bulky green crops and of all cereal ones—are inevitable and unmitigable. Even, too, in spite of waste needlessly incurred in soiling practices, and in spite also of clumsier and less economical methods of husbandry employed in raising the crops, the various trials recorded long ago in the Annals of Agriculture clearly demonstrate that a vastly greater number of stock may be kept upon the same extent of land by soiling than by depasturing.—But a third and even greater advantage is the obtaining of a comparatively vast quantity of excellent manure for the raising of rich crops on the additional lands made available for arable husbandry. In the depasturing system, the excrement of live stock contributes scarcely any thing in the way of fertilizement, being scattered about the fields and dissipated by strong exposure to the sunshine and the weather; or, on the whole, it is rather injurious than useful, blanching and burning the tender grass on the spots where it falls, and rendering them for a long time blank and practically barren. "But soiling with green food in summer is a method admirably calculated for producing an abundance of manure; as from the great increase in the urinary discharges in the consumption of green food in this way, and the heat of the season, the littering material, whatever it may be, is speedily converted into manure; by which means, with proper attention, vast stores of manure may consequently be raised, where there would otherwise be none. By these means the summer produce in manure may probably be made to exceed that of the winter, and at the same time be superior in quality, as there is reason to suppose, that the manure produced by any kind of cattle fed in the same way, when not in a state of fattening, is much better in the summer than in the winter season. The proportion of valuable manure that the careful farmer may be capable of providing by this system of management is scarcely to be conceived, except by those who have been in the practice. In this view it is of much importance to have reservoirs for the reception of the urine, in order that it may be occasionally thrown up over the litter, and thereby promote its more speedy conversion into manure."

In order to ensure the full benefits of soiling, the farmer who practises it must pay strict attention to the circumstances connected with it, —particularly to having convenient sheds and yards, to the providing of suitable crops in proper succession and in due proportion, to the orderly and regular cutting, carrying, and apportioning of the food, and to the full and constant supply of suitable materials for the purpose of litter. The sheds and yards, as to both relative position and internal arrangement, ought to be such as to economise labour in the feeding of the stock and in the making and accumulating of the manure. The crops raised should be so selected and proportioned as, in the aggregate, to afford a constant and steady supply of green food from the beginning of spring till the end of autumn. Rye and winter barley, sown early in autumn, will be ready for use in the earliest mild weather of spring; the same crops sown later with winter tares, and the young clover which was not cropped in autumn, will follow; the artificial grasses and the early-mown grass of water-meadows, will come next,—the latter modified and made palatable by intermixture of oats and cut-straw; and clover, spring tares from successions of sowings, and lucern and sainfoin on farms which have suitable soil for them, will fully and uninterruptedly maintain the supply till the commencement of winter-feeding. Other crops also, such as white mustard and succory, may be made to lend their aid. The supplies from the field to the feeding-place ought always to be fresh, regular, and exactly proportioned to the current wants of the stock. No food should be allowed to stand packed in the carts, or to be apportioned to the animals in large quantities at a time; for all is liable to pass rapidly into a state of incipient fermentation, and to become disagreeable and be rejected. The animals, too, thrive best by receiving their food in small quantities, at short intervals, and always in a perfectly fresh condition; and they ought, in every instance, to be fed at least three times a-day, and may with advantage be fed four times. Litter ought always to be supplied in abundance; and wherever sufficient provision cannot be made for it in the form of straw, stores ought to be laid up of ferns, rushes, forest leaves, and any other similar materials which can be found. Care ought also to be constantly practised that the sheds and yards be kept well ventilated, that the cribs, racks, and other feeding spots be kept perfectly clean, that the bodies of the animals be kept free from all sorts of dirt, that a plentiful supply of pure water be maintained in a situation of constant access to the animals, that the kinds of food be occasionally varied and always agreeable,

and that the animals be turned out into the open air during a few hours in the cool of the evening in summer, and in the middle of the day when the season advances.

SOILS (Analysis of). See Soil.

SOJA. An annual, tropical, culinary plant, of the vetch division of the leguminous order. It is a native of India, and was introduced nearly 60 years ago to British collections. It has a twining stem of about three feet in height, and carries violet-coloured flowers. It was formerly included in the genus Dolichos, but it now constitutes a genus of itself, and takes the specific name of hispid.

SOLANDRA. A genus of tropical, ornamental, ligneous plants of the nightshade order. Two climbing species of between 15 and 25 feet in height, and three evergreen shrubs of from 3 to 14 feet in height, have been introduced to the hothouse collections of Britain; and they love a rich soil, and are propagated from cuttings.

SOLANIA. A vegetable alkali, found in the woody nightshade, *Solanum dulcamara*, and in other plants of the solanum genus. It occurs in combination with malic acid, and is precipitated from the expressed and filtered juice of the ripe berries by means of ammonia. It is naturally impure and of a grey colour; but may readily be purified by solution in hot alcohol,—and is left by the slow evaporation of the solution in the form of a white pearly powder. It is insoluble in cold water, and soluble only in at least 8,000 times its weight of hot water. It has a bitter taste, and forms neutral salts by combination with acids.

SOLANUM. See Nightshade.

SOLDANELLA. A genus of low-growing, hardy, ornamental, evergreen, herbaceous plants, of the primrose family. Eight or nine species and well-marked varieties have been introduced to Britain from Switzerland and Germany, and are fine spring-blooming beauties of the open flower border. They have a height of only from two to six or seven inches, and for the most part carry either blue or purple flowers, and are propagated by division of the roots. The oldest known species, the alpine, *Soldanella alpina*, introduced from Switzerland about the middle of the 17th century, may be taken as a specimen of the whole. Its root is fibrous; its leaves stand on long footstalks, and are almost kidney-shaped, and have a dark green colour, and measure about three-fourths of an inch over each way; its floral footstalk rises from among the leaves, and is naked, and has a height of about 4 inches; its flowers are two in number, and appear at the top of the footstalk, and are small, open, and bell-shaped, with the rim cut into many fine segments like a fringe, and have commonly a blue or purple colour, but sometimes a snow-white one, and bloom in April; and its capsule is oval, and contains very small acute-pointed seeds, and ripens in July. It requires a shaded situation.

SOLDER. An alloy for cementing together two surfaces or edges of metal. Fine solder used by tinsmiths, and much employed for tinning copper, consists of two parts of tin and one of lead, and fuses at about 360° Fahrenheit; coarse solder, used by glaziers, contains one-fourth of tin, and fuses at about 500° Fahrenheit; and hard solder, used by braziers, and requiring the copper at the time of application to be heated to near its point of fusion, is a mixture of zinc and brass.

SOLE. See Plough and Foot.

SOLEA. An ornamental, hardy, perennial-rooted herbaceous plant, of the violet family. It is a native of North America, and was introduced about 60 years ago to Britain. It has a height of about a foot, and carries herbaceous-coloured flowers in June and July. It was formerly ranked as a true violet; but it now constitutes a genus of itself, and is specifically called the self-coloured.

SOLIDAGO. See Golden-Rod.

SOLLYA. A genus of ornamental, exotic plants, of the pittosporum family. The various-leaved and the narrow-leaved species, both evergreen, blue-flowered, summer-blooming twiners, of between 4 and 10 feet in height, were introduced to Britain in 1823 and 1830 from Australia; and they require greenhouse treatment, and love a soil of peaty loam, and are propagated from cuttings. Several other species have subsequently been introduced.

SOLOMON'S SEAL,—botanically *Polygonatum*. A genus of ornamental, perennial-rooted, herbaceous plants, of the smilax order. The common or angular or many-kneed species, *Polygonatum vulgare*, called by the old botanists *Convallaria polygonatum*, is a native of the rocky mountainous woods of some parts of England, and often has a place in gardens. Its root is creeping and fleshy; its stems are angular and from 12 to 30 inches high; its leaves are alternate, clasping, broadly elliptical, acute, ribbed, and plaited; its flowers come out on axillary drooping footstalks, and are generally solitary but sometimes binary, and are pendulous and conical, and have white and green colours, and emit a powerful odour similar to that of hawthorn or heliotrope, and bloom in May and June; and its fruit are dark blue berries, of a spherical form, about the size of those of ivy, each enclosing three seeds. The roots abound in a starchy jelly, and yield starch by grating and washing, and are said to have been used in the north of Europe for making bread. A variety with double flowers and a very sweet odour occurs in gardens.—The many-flowered species, *Polygonatum multiflorum*, called by the old botanists *Convallaria multiflora*, is a native of the woods and thickets of various parts of Britain. Its stem is smooth, cylindrical, and about 2 or 2½ feet high; its leaves have a lighter green colour than those of the common species; and its flowers number

from two to five on each stalk, and are more cylindrical and elongated than those of the common species, and have a white colour and a very faint odour, and bloom in May and June.—The whorl-leaved species, *Polygonatum verticillatum*, called by the old botanists *Convallaria verticillata*, is a native of the woods of some parts of Scotland, but is very rare. Its stem is 12 or 15 inches high; and its flowers are white.—Nine or ten species have been introduced from Nepaul, Caucasus, Continental Europe, and North America; and all are white-flowered, and love a soil of sandy loam; and, in common with the indigenous species, are most readily propagated by division of the root.

SOLORINA. A genus of lichens, of the idiothalamous tribe. The yellow species, *S. crocea*, is of some economical use as a dye-stuff. It occurs on the tops of mountains in some parts of Britain, and has an olive-green colour, and a height of about 1½ inch. The hollowed species, *S. saccata*, inhabits earthy spots in Britain, and has a greyish colour, and a height of about 2 inches. Both these species have the form of leafy fronds.

SONCHUS. See Sow-Thistle.

SOOT. Condensed or embodied smoke. It is clammy and earthy, and possesses a certain degree of volatility; yet, though all originally smoke, it cannot be re-expanded into that state. It condenses on the sides of chimneys, and has escaped perfect combustion in consequence of insufficient contact with oxygen. It owes its blackish and brownish colours to the presence of carbonaceous matter in a condition similar to that of smotheredly burnt oil. It affords by distillation ammoniacal salts and empyreumatic oil, and yields to hot water a brown extract of a bitter taste; and when burnt in an open fire, it flames with a thick smoke, and produces other soot, which is used in making sal ammoniac. A specimen of soot taken from a chimney where wood had been the fuel was found by M. Braconnot to contain 30 per cent. of ulmic acid, 20 of azotic matter soluble in water, 3·9 of insoluble carbonated matter, 1 of silica, 14·7 of carbonate of lime, a trace of carbonate of magnesia, 0·5 of sulphate of lime, 1·5 of ferruginous phosphate of lime, 0·4 of chloride of potassium, 4·1 of acetate of potash, 5·7 of acetate of lime, 0·5 of acetate of magnesia, a trace of acetate of iron, 0·2 of acetate of ammonia, 0·5 of an acrid and bitter principle, and 12·5 of water. But soot greatly varies in composition, according to the nature of the substances from whose combustion it is obtained, and according to the dimensions of the chimney and the intensity of the heat. Soot from the combustion of coals is usually reckoned better for manure than that from the combustion of wood or peat; and soot from kitchen chimneys impregnated with the effluvia of cooked victuals, better than that from the chimneys of a parlour or a furnace; and soot from any chimneys of ordinary dwelling-house heat and draught, very much better than from chimneys whose heat and draught are great. Its most active manurial principle in any case seems to be its ammonia; and this is commonly exhausted in a single season, and sometimes acts so energetically as to deteriorate the succeeding crops. Its fertilizing action is more favourable to potatoes than to turnips, and more to the cereal and the pasture grasses than to clover or any other leguminous crops.

Soot mixed into water, in the proportion of about six quarts to a hogshead, has been found an excellent liquid manure for the purposes of the garden. "Asparagus, pease, and a variety of other vegetables," says Mr. John Robertson, "I have manured with it with as much effect as if I had used solid dung. But to plants in pots, particularly pines, I have found it admirably well adapted. When watered with it, they assume a deep healthy green, and grow strong and luxuriant. I generally use it and clean water alternately, and always overhead in summer; but except for the purpose of cleansing, it might be used constantly with advantage." It probably might also have the advantage of keeping pines pretty clear of scale and bugs.

A compost of soot and soil and farm-yard manure forms a sort of soapy earth, and serves as a good top-dressing to meadows, and acts beneficially on almost all kinds of plants. The mixture should be formed of two parts of earth, one part of soot, and one part of dung. A layer of earth should be covered with soot, over which a layer of dung should be placed, and thus alternate layers must be arranged in a bed about three or four feet high, and three wide. Soot, mixed with the earth dug from the ditches in the proportion of one-fourth, may, in about six months afterwards, be used with success in dressing meadows. Of this latter mixture about thirty bushels should be used to the acre. Spread on wet grounds, it will destroy the moss, and neutralize the bad qualities of the soil. When soot is applied in its simple state, it is found to answer best on light gravel, limestone, or chalk soils; but, in a state of compost, it is equally useful and applicable to almost any soil, provided the compost be such as to maintain its powers in their integrity. "The most approved mixture," says Sir John Sinclair, "is one part soot, five parts earth, one part lime. The earth and soot should be well mixed, and remain ten days at rest, then be turned, and the lime added in regular strata, as it is turned over. In this state it may continue for five or six weeks, when it ought to be turned a second time, breaking every piece as small as possible, by working it well with the spade. In a week or two more, it will be ready for use." But Sir John, notwithstanding his distinguished eminence as an agriculturist, was no agricultural chemist, and has here fallen into a gross error, and recommended a very bad practice under the description of "most approved;" for the mixing of lime with soot withdraws the latter's ammonia, and

in consequence denudes it of its chief principle of value.

Soot, either in its simple state or in mixture with water, has long been used by many farmers as a top-dressing on culmiferous crops and on grass lands, and also on turnips soon after brairding as a preventive of the fly. "On wheats that look sickly or infested with the grub worms," says Mr. Donaldson, "soot will work a great change in restoring the green healthy colour, and in causing much tillering from the roots. On clovers, tares, and on all young grasses and grass lands, the effects will be equally beneficial; and also on young barley and on all spring crops. It may also be harrowed in with the seeds of any crops in the spring on well pulverized lands; but as moisture is necessary for its operation, it may sooner derive the assistance of that element by lying on the surface as a top-dressing." "In 1838," says Mr. Main, "I applied soot to a field of wheat which, at the time, seemed in so very precarious a state as to make me even despair of its recovery. After applying the soot, however, it rallied; and when cut down, there was not a better crop on the farm. I also tried the effects of soot on a small piece of pasture, upon which a few sheep were afterwards put to graze. The result was curious. There were many other ridges in the field besides those dressed with soot, and all good grass; but the sheep continued to eat the sooted ridges until they were completely bared. With faces quite blackened they fed heartily on the soot-dressed pasture." Cattle also have been observed to prefer the grass grown on lands dressed with soot; and extensive pastures in some districts where the practice has been followed of giving them copious top-dressings of soot every year, have acquired a sort of celebrity for the vivid green of their verdure. The best time of application, in the case of almost all the crops and lands which derive most benefit from soot, is March or April; the kind of weather always desirable at the time of application, and which ought to be waited and watched for, is mild, calmly windy, and moist or showery; and the quantity proper for manurial top-dressing, varies from 20 to 100 bushels per acre, and averages between 40 and 60,—and for prevention of the fly on young turnip-crops, is about 20. Soot in its simple state has also been used in the garden, both dug into the soil and in the way of top-dressing, as a preventive of the worm in carrots and other culinary plants; but whenever it is the best thing which a gardener or cottier can obtain for any horticultural purpose, it ought to be applied in mixture with water in the way of liquid manure.

The common mode of applying simple soot as a top-dressing in the field is by hand-sowing. The waggon or cart containing it should be driven across the wind; and the sowing should be so done that the soot may be gently carried away by the wind from the horses and the sower. But a soot-distributing machine was invented a few years ago by Mr. Main, and is described and figured in the 12th volume of the Highland Society's Transactions, and may be well worth the attention of any farmer who purposes to make extensive use of soot. It comprises a chest mounted on two wheels, from which motion is communicated to a sheet-iron cylindrical riddle, in which the soot is placed. The soot is separated by the riddle from the stones and mortar which are generally mixed with it; and it falls thence to the bottom of the chest, and falls through orifices of this to the ground in a very similar way to that in which the seeds fall from a broadcast-sowing machine. —*Davy's Agricultural Chemistry by Shier.—Donaldson on Manures.—Repertory of Inventions.—General Report of Scotland.—Loudon's Gardener's Magazine.—Transactions of the Highland Society. — Q. Journal of Agriculture. — Boussingault's Rural Economy.—Bayldon on Rents and Tillages.*

SOPHORA. A genus of ornamental exotic plants, constituting the type of a large tribe of phyllolobous leguminosæ. See the article Leguminous Plants. The Japanese species, *S. japonica*, is a deciduous timber-tree of Japan, and was introduced to Britain, according to various statements, in 1780, in 1763, or in 1753. It has been cultivated in France since 1717; and it is quite hardy in Britain, and occupies a somewhat prominent place in good collections of small ornamental trees. It attains a height of upwards of 20 feet; with a proportionate diameter. Its wood, when fresh cut, emits an odour offensive to insects; its leaves are pinnated and smooth, and have a beautiful green colour, and give to the tree a graceful appearance; its flowers are white, and bloom in August and September; and its pods are long, slender, one-celled, and numerous, and have prominent knobs on the surface. It is propagated from seeds, sown as soon as they can be procured in pots filled with light earth; and its plantlets should be planted in a sandy loam, and in a sheltered situation. One variety of it is pendulous, and another has variegated leaves.—The Chinese species, *S. sinensis*, was introduced to Britain from China in 1818; and is also a hardy, deciduous, white-flowered, small tree, scarcely so tall as the Japanese. — Four hardy, perennial-rooted, herbaceous species, of from 1½ to 4 feet in height, and chiefly yellow-flowered, have been introduced from Siberia, North America, and the Levant; and a number of tropical, evergreen, ligneous species, varying in height from 3 to 20 feet, and carrying variously white, yellow, violet, or purple flowers, have been introduced from India and tropical America.

SOPHRONITIS. A genus of ornamental, tropical, epiphytous plants, of the orchis order. It is nearly allied to the splendid genus cattleya. The drooping species, *S. cornua*, was introduced to Britain from Rio Janeiro in 1827,—and the large-flowered species, *S. grandiflora*, from the

Organ mountains in 1837; and the former is 3 or 4 inches high, and has red flowers,—the latter 6 or 8 inches high, and has scarlet flowers.

SORBUS. See PYRUS and ASH (MOUNTAIN).

SORGHUM. See INDIAN MILLET.

SOROCEPHALUS. A genus of ornamental, evergreen, purple-flowered, Cape-of-Good-Hope shrubs, of the protea family. Seven or eight species, varying in height from 2 to 4 feet, and chiefly blooming from about midsummer till the early part of autumn, have been introduced to the gardens of Britain; and most love a soil of loamy peat, and are propagable from cuttings.

SORREL. Three hardy, culinary, perennial-rooted herbaceous plants, of the dock genus. Two of them, the common sorrel and the sheep's sorrel, are natives of Britain; and the other, French sorrel, was introduced about 250 years ago from France.

Common sorrel, *Rumex acetosa*, is the best known and naturally most abundant of the three species. Its root is long, tapering, and somewhat woody, and has astringent properties; its stem is cylindrical, striated, erect, simple, leafy, and from 12 to 24 inches high; its leaves are oblong, ovate, and arrow-shaped,—smooth in texture, and powerfully and agreeably acidulous,—the radical ones stalked and obtuse,—and the cauline ones sessile, clasping, pointed, and a little rolled back; and its flowers are dicœcious, and grow in branched panicles, arranged in half-whorls, and have permanent tuberculated petals of a greenish colour, and bloom in June and July. The astringency of the root is due to tannic acid; and the acidulousness of the leaves to tartaric acid and the binoxalate of potash.

Sorrel inhabits the wild grassy pastures of most parts of Continental Europe, from Greece to Lapland; and it is common in many of the pastures, both high and low, of Britain,—and it indicates a sour state of the soil, which cannot ordinarily be corrected without an application of calcareous manure,—and as it is never eaten by live stock, except when they are hard pressed by hunger, and cannot get better food, it has practically the character of a rank coarse weed, which both impoverishes the ground by its own growth, and keeps down useful herbage by its occupancy and its shade. It becomes specially abundant and luxuriant in seasons when the spring growth of the grasses is backward and stunted; it seems generally to abound in the proportion in which free humic acid exists in the soil; it can easily be kept down or starved out by means of liming or of the application of soap-maker's waste; and the extermination of it from some fields which it specially infests, would permanently increase their value from 30 to 50 per cent.

Sorrel has been celebrated from very ancient times for its cooling, antiscorbutic, diuretic, and gratefully esculent properties. The expressed juice of its leaves, or a decoction of them in whey, affords an useful drink in cases of inflammatory fever; and the leaves themselves, eaten freely as a salad, cool the blood and act as either a cure or a preventive of scurvy. The plant is cultivated in France and in some English gardens as a highly esteemed pot-herb, and for use at all seasons in soups, sauces, and salads; it is far worthier of a large and constant place in the kitchen garden than many of the plants which commonly figure there; and it seems to be hindered only by the caprice of fashion from being a general and useful favourite. It is even employed in some parts of northern Europe, in seasons of scarcity, as one of several substitutes for bread. It thrives best in any garden mould which is moderately rich and more friable than tenacious; and it may be raised either from seeds sown in spring, and the seedlings transplanted, or from offsets and divisions of the root in either spring or autumn, planted at distances of a foot.

The sheep's sorrel, *Rumex acetosella*, is a common and plentiful weed of dry banks and gravelly soils in most parts of Britain; and, whenever it gets possession of any spot of ground, it propagates itself promptly and rapidly by means of its spreading roots, and soon becomes abundant. Its stem is wavy, slender, often decumbent, and generally about a foot long; its leaves, in the lower part of the stem, are hastate,—and in the upper part, lanceolate-hastate; and its flowers are dicœcious, small, and separate, and grow in numerous, whorled, leafless clusters, and bloom from May till July. This plant has similar taste and properties to the common dock, and was formerly noticed in the dispensatories as a medicinal plant; but it is inferior to the common dock, and is not so much used.

The French or Roman or bucklered sorrel, *Rumex scutatus*, closely resembles the common sorrel in properties and uses, but has a different habit of growth, and loves a light, dry, rich soil in an open situation, and is preferred by some persons on account of the facilities of its cultivation, and by others for the sake of its superior adaptation to soups. "It is," says Miller, "a great runner at the root, by which means it is easily propagated, and must be planted at a large distance, two feet square at least. And if the flower-stems and rambling branches are cut off in the beginning of July, the roots will soon put out new leaves; so that by cutting down the shoots of some plants at different times, there will always be a supply of young leaves, which is the only part of the plant used in the kitchen."

SORREL (MOUNTAIN). See MOUNTAIN SORREL.

SHEEP SORREL. See SORREL.

SORREL TREE. A hardy, evergreen, ornamental, North American tree, of the andromeda genus, and heath order,—*Andromeda arborea*. It was introduced to Britain about the middle of last century. It commonly attains a height of about 40 feet; and it carries white flowers from

July till September. It loves a soil of sandy peat, and is propagated from seed.

SORREL (Wood). See Wood Sorrel.

SOUNDNESS. Freedom from injury or defect,—or, in the case of a horse, the absence of everything which impairs now, or may probably impair hereafter, his natural usefulness. The constituents of soundness in horses are ill defined, both in the phraseology of common life and in that of the law; and they afford occasion for a perfect wilderness of disputes in the horse-market, and render it quite unsafe for an inexperienced person to purchase a horse without the aid of a professional man, or without a full written warranty of soundness from the seller. Youatt pronounces unsoundness to have "reference only to disease, or to that alteration of structure which is connected with or will produce disease, and lessen the usefulness of the animal;" and he enumerates, as "the usually supposed appearances or causes of it," broken knees, capped hocks, contraction, corns, cough, roaring, wheezing, whistling, high-blowing and grunting, cribbiting, curb, cutting, enlarged glands, enlarged hock, inflammatoriness of the eyes, lameness, neurotomized leg, ossification of the lateral cartilages, pumiced foot, quidding, quittor, ringbone, sandcrack, spavin, bog-spavin, splint, string-halt, thickening of the back sinews, thoroughpin, thrush, and windgalls. See the article Warranty.

SOUR GOURD. See Adansonia.

SOUR GUM. See Nyssa.

SOURCIC ACID. See Apocrenic Acid.

SOUR LAND. Land which contains free humic acid, and requires an application of calcareous manure for the promotion of its fertility. See the articles Soil and Lime.

SOUTHERNWOOD. Several species of hardy ornamental plants, of the wormwood genus.—The field species, *Artemisia campestris*, grows wild in the sandy fields of some parts of England, but is rare. It is a perennial-rooted herb, and possesses little resemblance to the ordinary southernwoods of gardens, and has no aromatic or bitter flavour. Its stems are straight, wand-like, leafy, smooth, often reddish, and commonly from 12 to 24 inches long, and at first are prostrate, but afterwards become more or less upright as the flowers appear; its leaves are irregularly and doubly pinnatifid, and have blunt and in many instances linear leaflets; and its flowers are ovate, small, and drooping, and have a yellow colour with a purplish calyx, and form numerous slender leafy clusters at the ends of the stems and the branches, and bloom in August. A variety called the alpine, *A. c. alpina*, was introduced about 30 years ago from Switzerland.—The most common southernwood of gardens, *Artemisia abrotanum*, is a native of the south of Europe, and was introduced to Britain about the middle of the 16th century, and has long been one of the most favourite ornamental plants of cottage flower-plots, and is everywhere known and liked for the agreeable aromatic odour of its herbage. It is a hardy deciduous shrub, of commonly about 4 feet in height. Its stems are simple; its leaves are bipinnatifid and smoothish; and its flowers have a herbaceous colour, and bloom from August till October. It thrives in any common garden soil, and is easily propagated from cuttings. —The other garden southernwoods have a general resemblance to the abrotanum; yet, in some instances, are quite as like the mugworts and the true wormwoods; and they greatly vary in odour, in hoariness, in foliage, and in other characters. See the articles Mugwort and Wormwood.

SOW. See Hog.

SOWBREAD. See Cyclamen.

SOWENS. See Oat.

SOWERBÆA. An ornamental, greenhouse, pink-flowered, evergreen, herbaceous plant, of the asphodel family. It is a native of Australia, and was introduced about 56 years ago to Britain. It has commonly a height of about a foot; and blooms from May till July. It constitutes a genus of itself; and is specifically called *juncea*, or "the rush-leaved."

SOWING. The depositing of seed in the soil. The several methods of it are comprised in broadcasting, drilling, and dibbling, and are described in the articles Broadcast-Sowing, Drill-Husbandry, and Dibbling. The comparative advantages of the broadcasting and the drilling methods are also noticed in the article Drill-Husbandry. Points preliminary to sowing, and having reference to the seed, are discussed in the article Seed; points preliminary to sowing, and having reference to the state of the soil, are discussed in the article Ploughing; some points which have reference to the economy of sowing are noticed in the article Agricultural Seeds; points which have reference to the season and meteorological circumstances of sowing are noticed in the articles on all the principal field and garden crops; subjects connected with the implements specially employed in sowing are noticed in the articles Sowing Machines and Implements; and points which have reference to the immediate chemical and physiological results of sowing are discussed in the article Germination.

The comparative advantageousness of thick and of thin sowing is complicated with the comparative advantageousness of the broadcasting and the drilling methods, with the specialities or modifications in the practice of each, with the nature, condition, and tilth of the soil, with the season, weather, and other circumstances of sowing, and with the species and varieties of the crops sown; so that both arguments from theory and appeals to experiment may very readily be conducted with such incautiousness or such incomprehensiveness as to bring out apparently triumphant conclusions on either side of the

question. Most of the reports of experiments which have been published, and which have given rise to much keen discussion, whether those which favour thin sowing or those which favour thick sowing, throw little or no real light on the general question, and are useful principally in pointing out certain combinations of circumstances in which respectively thin sowing and thick sowing have been found most advantageous. One of the most judicious of the experimenters who brings out results in favour of thin sowing, and who tried both barley and wheat in different quantities in the drill method, is candid and comprehensive enough to say, "Thin sowing should be early sowing on heavy land. It would be a dangerous experiment to sow thinly unless the land were drained, subsoiled, and kept free from weeds by the horse-hoe. Some allowance should be made for game near preserves. On reclaimed bog, or deep rich vegetable soil, I find it imperative to sow thin, or the crop would be mostly straw. Thin sowing somewhat delays the ripening of a crop, especially of wheat sown on heavy land so late as November or December. In cold or elevated districts, thin sowing, to succeed, must be very early. In my experiments, anything beyond one bushel of wheat seed per acre has not had the effect of increasing the yield, the extra seed being lost. It is a singular fact that the one bushel per acre never changed yellow in the spring, but went on with a healthy green cast without a check; the two bushels turned yellow, and the three bushels yellower, and was decidedly the worst stetch in the field. I would venture to suggest that each farmer should satisfy his own mind by trying part of an acre on each field. We seldom hear complaints of the losses from thick sowing in rich soil; they are, however, very serious in moist luxuriant summers. Two friends of mine sowed 4 bushels per acre, and only got 4 quarters of grinding barley, which sold at 27s. 6d., — they had an abundance of crowded weakly straw, which was laid early; mine, dibbled at 3 pecks per acre in not near so good a soil, produced 6 quarters, which sold for 33s. 6d., with strong straws and ears containing 17 to 19 kernels on each side." A writer on the opposite side of the question, and who at first seems almost red hot against thin sowing, also makes concessions and modifications which show that the whole question is one of an aggregate of circumstances, and ought to be decided by each farmer for himself according to soil, crop, season, and culture. "No harm," remarks this writer, "can eventually result from testing the thin-sowing plan of farming, although I expect many a poor farmer will be induced to try it, and pay for the trial by the loss of half of one year's crop. We all know that, if the land be sown with too much seed, the crop is injured— and if carried to a great extent, would be entirely lost,—the truth of which every one can testify from his own observation. On the other hand, too little seed will have the effect of depriving the farmer of a full crop. The question then is, what is a fair amount of seed to sow? I take it that that entirely depends upon the quality and situation of the land. If a person were to sow two pecks of wheat to the acre upon the Surrey hills, he would have room enough at harvest to drive a coach and four between the plants, because although it seems a paradox to say that the poorest land requires the most seed, it certainly is so, and for the following reasons: —first, because the land being cold and poor, and perhaps stiff, a very great proportion of the seed will not vegetate at all; and secondly, because upon poor land the plants do not tiller as they do upon good land. The only justification for sowing a small quantity of seed upon poor land would be drilling it in; but this operation could not well be performed upon the flinty hills of Surrey; and if it could, the seed should be deposited very close, for the reason given above, namely,—because the plants do not tiller or branch out,—also because horse-hoeing, so necessary when the crop stands thin upon the ground, cannot be performed satisfactorily, if at all, upon ground which contains so many flints as the Surrey hills do. It is another thing upon good rich fertile land, where every grain deposited will vegetate, and which, when up, will, in the spring tiller and increase its number of plants, and not only so, but will bring them all to perfection. The land also, being kind, can be horse-hoed, and nourishment added by the operation."

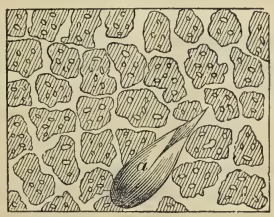
Two main things which claim attention in connexion with sowing — things on which the economising of the seed, the success and vigour of germination, and the regularity, strength, and luxuriance of the crop, very largely depend—are the proper mechanical condition of the soil, and the proper and uniform depth at which the seed is deposited; and these are so admirably stated in a lecture of Dr. Madden, which was read to a meeting of agriculturists at the great annual show of the Highland Society in Edinburgh, in August 1842, and afterwards published in the 14th volume of the Society's Transactions, that we cannot do better than present an abstract of that lecture to our readers:—

"The most careful examination has proved, that the process of germination consists essentially of various chemical changes, which require for their development the presence of air, moisture, and a certain degree of warmth. Now, it is obviously unnecessary for our present purpose, that we should have the least idea of the nature of these processes: all we require to do, is to ascertain the conditions under which they take place; having detected these, we know at once what is required to make a seed grow. Viewing matters in this light, it appears that soil does not act chemically in the process of germination,—that its sole action is confined to

its being the vehicle by means of which a supply of air, and moisture, and warmth, can be continually kept up. With this simple statement in view, we are quite prepared to consider the various conditions of soil, for the purpose of determining how far these will influence the future prospects of the crop; and we shall, accordingly, at once proceed to examine carefully into the mechanical relations of soil. This we purpose doing by the aid of figures.

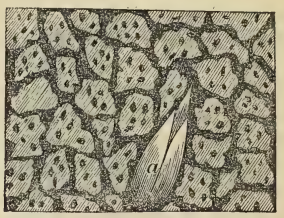
"Soil, examined mechanically, is found to consist entirely of particles of all shapes and sizes, from stones and pebbles down to the finest possible powder; and, on account of their extreme irregularity of shape, they cannot lie so close to one another as to prevent there being passages between them, owing to which circumstance, soil in the mass is always more or less porous. If, however, we proceed to examine one of the smallest particles of which soil is made up, we shall find that even this is not always solid, but is much more frequently porous, like soil in the mass. A considerable proportion of this finely divided part of soil, the impalpable matter as it is generally called, is found, by the aid of the microscope, to consist of broken down vegetable tissue; so that when a small portion of the finest dust from a garden or field is placed under the microscope, we have exhibited to us particles of every variety of shape and structure, of which a certain part is evidently of vegetable origin. In these figures I have given a very rude representation of these particles; and I must beg you particularly to remember that they are not meant to represent, by any means accurately, what the microscope exhibits, but are only designed to serve as a plan by which to illustrate the mechanical properties of the soil.—On referring to *fig.* 1, we perceive that there are

Fig. 1.



two distinct classes of pores,—1st, the large ones, which exist between the particles of soil, and, 2d, the very minute ones, which occur in the particles themselves; and you will at the same time notice, that whereas all the larger pores, those between the particles of soil, communicate most freely with each other, so that they form canals, the small pores, however freely they may communicate with one another in the interior of the particle in which they occur, have no direct connexion with the pores of the surrounding particles. Let us now, therefore, trace the effect of this arrangement. In *fig.* 1, we perceive that these canals and pores are all empty; the soil being perfectly dry, and the canals communicating freely at the surface with the surrounding atmosphere, the whole will of course be filled with air. If, in this condition, a seed be placed in the soil, as at *a*, you at once perceive that it is freely supplied with air, but there is no moisture; therefore, when soil is perfectly dry, a seed cannot grow.—Let us turn our attention now to *fig.* 2. Here we perceive that both the pores and canals are no longer represented white but

Fig. 2.



black, this colour being used to indicate water. In this instance, therefore, water has taken the place of air, or in other words, the soil is very wet. If we observe our seed *a* now, we find it abundantly supplied with water, but no air. Here again, therefore, germination cannot take place. It may be well to state here, that this can never occur exactly in nature, because water, having the power of dissolving air to a certain extent, the seed *a* in *fig.* 2 is in fact supplied with a certain amount of this necessary substance; and, owing to this, germination does take place, although by no means under such advantageous circumstances as it would were the soil in a better condition.—We pass on now to *fig.* 3. Here we find a different state of matters. The canals are open and freely supplied

Fig. 3.

with air, while the pores are filled with water; and consequently you perceive that, while the seed *a* has quite enough of air from the canals, it can never be without moisture, as every particle of soil which touches it is well supplied with this necessary ingredient. This, then, is the proper condition of soil for germination, and in fact for every period of the plant's development; and this condition occurs when soil is moist, but not wet; that is to say, when it has the colour and appearance of being well watered, but when it is still capable of being crumbled to pieces by the hands, without any of

its particles adhering together in the familiar form of mud.—Turning our eyes to *fig.* 4, we

Fig. 4.

observe still another condition of soil; in this instance, as far as water is concerned, the soil is in its healthy condition—it is moist, but not wet—the pores alone being filled with water. But where are the canals? We see them in a few places, but in by far the greater part of the soil none are to be perceived; this is owing to the particles of soil having adhered together, and thus so far obliterated the interstitial canals that they appear only like pores. This is the state of matters in every clod of earth *b*; and you will at once perceive, on comparing it with *c*, which represents a stone, that these two differ only in possessing a few pores; which latter, while they may form a reservoir for moisture, can never act as vehicles for the food of plants, as the roots are not capable of extending their fibres into the interior of a clod, but are at all times confined to the interstitial canals.

"With these four conditions before us, let us endeavour to apply them practically, to ascertain when they occur in our fields, and how those which are injurious may be obviated. The first of them, we perceive, is a state of too great dryness, a very rare condition, in this climate at least; in fact, the only case in which it is likely to occur is in very coarse sands, where the soil, being chiefly made up of pure sand and particles of flinty matter, contains comparatively much fewer pores; and, from the larger size of the individual particles, assisted by their irregularity, the canals are wider, the circulation of air freer, and consequently the whole is much more easily dried. When this state of matters exists, the best treatment is to leave all the stones which occur on the surface of the field, as they act as shades, and thereby prevent or retard the evaporation of the water. We will not, however, make any further observations on this very rare case, but will rather proceed to *fig.* 2, a much more frequent, and, in every respect, more important condition of soil,—I refer to an excess of water. When water is added to perfectly dry soil, it of course, in the first instance, fills the interstitial canals, and from these enters the pores of each particle; and, if the supply of water be not too great, the canals speedily become empty, so that the whole of the fluid is taken up by the pores; this, we have already seen, is the healthy condition of soil. If, however, the supply of water be too great, as is the case when a spring gains admission into the soil, or when the sinking of the fluid through the canals to a sufficient depth below the surface is prevented, it is clear that these also must get filled with water so soon as the pores have become saturated. This, then, is the condition of undrained soil. Not only are the pores filled, but the interstitial canals are likewise full, and the consequence is, that the whole process of the germination and growth of vegetables is materially interfered with. Of course all the injurious effects are at once overcome by thorough-draining, the result of which is to establish a direct communication between the interstitial canals and the drains, by which means it follows, that no water can remain any length of time in these canals without, by its gravitation, finding its way into the drains.—The fourth figure indicates badly cultivated soil, or soil in which large unbroken clods exist. Too much cannot be said in favour of pulverizing the soil; even thorough-draining itself will not supersede the necessity of performing this most necessary operation. The whole valuable effects of ploughing, harrowing, grubbing, &c., may be reduced to this; and almost the whole superiority of garden over field produce is referable to the greater perfection to which this pulverizing of the soil can be carried. The whole success of the drill husbandry is owing, in a great measure, to its enabling you to stir up the soil well during the progress of your crop; which stirring up is of no value beyond its effect in more minutely pulverizing the soil, and increasing, as far as possible, the size and number of the interstitial canals. Lest any one should suppose that the contents of these interstitial canals must be so minute that their whole amount can be of but little consequence, I may here notice the fact, that in moderately well pulverized soil they amount to no less than one-fourth of the whole bulk of the soil itself. For example, 100 cubic inches of moist soil (that is, of soil in which the pores are filled with water while the canals are filled with air) contain no less than 25 cubic inches of air. According to this calculation, in a field pulverized to the depth of 8 inches, a depth perfectly attainable on most soils by careful tillage, every imperial acre will retain beneath its surface no less than 12,545,280 cubic inches of air. Taking into the calculation the weight of soil, we shall find that, with every additional inch which you reduce to powder (by ploughing, for example, 9 inches in place of 8), you call into activity 235½ tons of soil, and render it capable of retaining beneath its surface 1,568,160 additional cubic inches of air. And to take one more element into the calculation, supposing the soil were not properly drained, the sufficient pulverizing of an additional inch in depth would increase the escape of water from the surface by upwards of 100 gallons a day, a quantity

which would very soon tell upon the dryness of soil, if there were a continuance of dry weather for several successive days, more especially if this were accompanied by sunshine. From what I have now stated, I humbly hope that you cannot fail to perceive the close connection which subsists between the mechanical condition of the soil and the result of germination; and that you have at the same time felt satisfied of the degree of certainty and point which all the processes of preparing the soil assume, when the principles on which they depend are fully understood and appreciated.

"Hitherto we have spoken only of the condition of the soil at seed-time; we shall now examine into the various methods in use for sowing the seed, and determine what effect these can have upon the value of the resulting crop. It is well known to you all, that, until lately, the grain crops were almost universally sown broadcast upon the furrow-slice, which process has the effect of imitating, to a certain extent, the drill-system. A very few considerations, however, will suffice to point out, that with this system of sowing your success is so far dependent upon the skill of your workmen, that you may be considered completely at their mercy. To demonstrate this, let us refer to the figures below, which are designed to show the effects produced by bad ploughing and bad sowing, as compared with the results obtained by the use of machines. In *fig.* 5, you have an example of bad ploughing. You will at once perceive, that, in this case, the ploughman has either had a very unsteady pair of horses, or has been but little experienced in his employment. At *a*, for example, he has given his plough too much land, and has turned over a slice considerably broader than it should be, thus producing, as is shown in *fig* 6, a space in which too much seed will lodge. At *b* he has laid the slice too upright, thus producing what is technically termed a proud furrow, and which in another manner affects the sowing by allowing the seed to slip down between the two slices, and consequently become buried to far too great a depth below

Fig. 5.

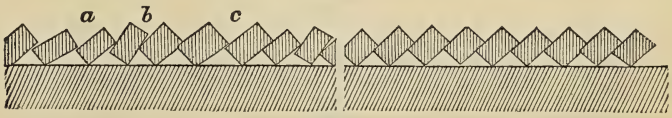


Fig. 6.

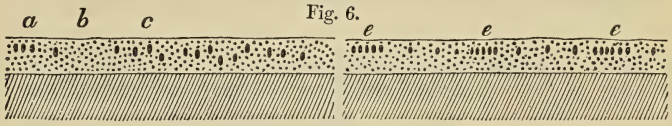
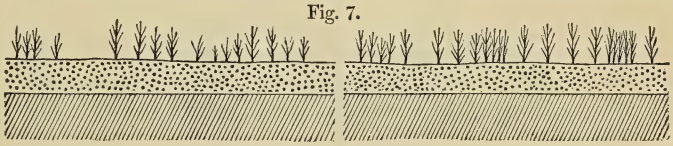


Fig. 7.

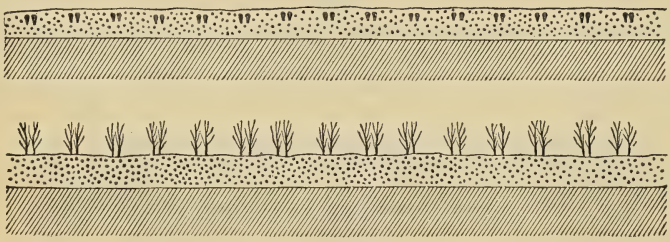


the surface. Again at *c*, by leaning the plough to the side, he has turned over a slice considerably thicker at the top than the bottom, which, in its turn, will influence the crop by stirring too little soil at certain places, and thus producing an active soil of different thicknesses. Besides these, there are various other faults in ploughing, each one of which has a distinct and visible influence on the growing of the crop. On a field thus carelessly turned over, the sower proceeds to scatter the seed; and here, again, you will at once perceive the effect which the performance of this operation will have on the resulting crop. To the left of *fig.* 6, I have supposed a good sower to be employed, but still he is labouring under the disadvantage of following a bad ploughman. The figure represents in section the position of the seeds as determined by the condition of the furrow-slice, and you will at once notice several important errors. At *a* there is too much seed; at *b* it is far too deep below the surface; at *c* it is much nearer the surface, and so forth. On the right, again, of *fig.* 6, I have endeavoured to represent the injury affected by a bad distribution of the seed, even although the ploughing has been performed in the most masterly style, as in the furrow-slices immediately above in *fig.* 5. In this case at *e* the seed is far too thick, owing to his not having opened his hand soon enough when delivering it out, and on this account the crown of the ridge is much too thinly supplied. This is a very serious, but I fear too common a fault; at least, if we carefully observe the brairding of the fields in spring, there is nothing more common than to see the furrows green, whilst the crowns of the ridges are still nearly bare.

"Let us now turn our attention to the results likely to be produced by these various errors. We have already seen that the requisites for germination are air, moisture, and a certain degree of warmth; and I may here observe, that the

temperature has a very decided influence upon the time required for germination, and that, within certain limits, the higher the temperature is the more rapidly does the process go on. But it must be kept in mind, that soil receives its heat through the medium of the air, and that, consequently, the surface is always more quickly heated than that deeper down. In fact, the heat progresses so slowly from above downwards, that it has been found that at a certain depth beneath the surface, the temperature of summer is not felt until the following winter. Whenever the air is warmer than the soil, the surface of the soil will be warmer than that below the surface; when, on the other hand, the air is cooler, the surface of the soil will, by contact, cool much more rapidly than that below the surface. From this state of matters it follows, that the most rapid germination will occur at about 1 inch or so below the surface, to which depth the heat will soon penetrate, and which, nevertheless, will not be so readily cooled during the night. On this account, the seeds at this level will generally grow most rapidly, and the germination of others will occupy more and more time, as the distance between them and the surface is increased. It is owing to this fact that seeds too deep sown do not grow at all, the temperature not being sufficiently elevated, and the supply of air too limited to set the chemical processes at work which are essential to germination. In *fig.* 7, we perceive this result very clearly demonstrated; for, while the plants at one spot, where the seeds were about 1 inch below the surface, have attained a good size, those which slipped down between the furrow-slices from the bad ploughing, have scarcely yet appeared above ground, as below *a* and *b* of *fig.* 6. Turning your attention to *fig.* 8.

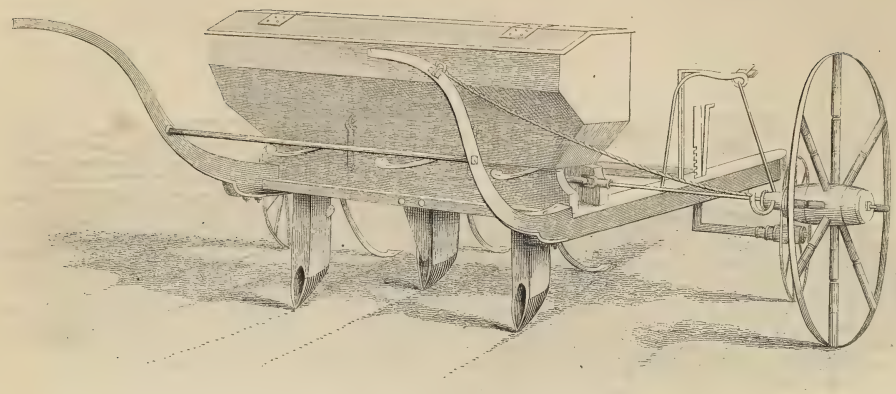
Fig. 8.



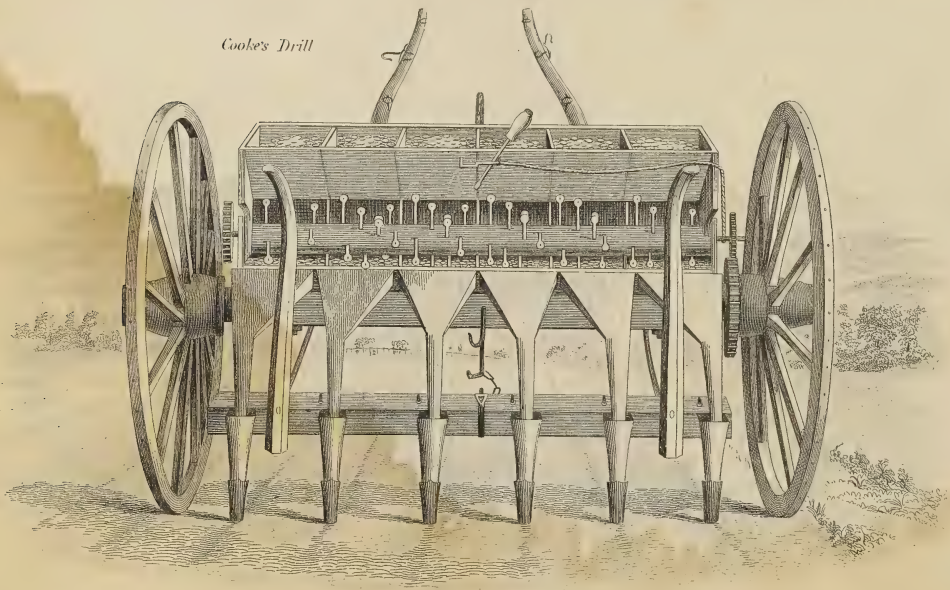
you will at once perceive the immense advantage of the machine over the hand-sown crop. In this case, you can work up your land to any degree of fineness you please, by harrowing, grubbing, rolling, &c. You are preserved from every injury arising from a careless distribution of the seed; and even the errors of your ploughmen have not so serious an effect upon the result of the crop. The machine delivers the seed, as in the upper figure, with the greatest exactness, at any depth you please, and the result is, as shown in the lower figure, the greatest equality in the braird."

SOWING-MACHINES. Implements for the easy and regular distribution of seeds alone or of seeds and special manures. They did not acquire a very refined character till a comparatively recent period, and they are still unused, in even their rude state, in some of the remote and least improved districts of Britain; yet they have been known for centuries in both the extreme east and the extreme west of the civilized world, and have, for a long period, been progressively multiplied in form and kind, and anxiously studied and improved by some of the ablest agricultural mechanicians. The farmers of China, India, Japan, and Arabia have, from time immemorial, drilled and dibbled in their seeds. The Chinese sowing-machine of the present day resembles in some respects a hand-barrow and in others a small plough, and has three hollow teeth of about 28 inches in length with iron supports, and carries the seeds in a box above the wheels, and drops them thence through the teeth to the ground, in rows of from 7 to 14 inches distant; and it follows the plough, and is itself followed by a small wooden roller, which covers the seeds and supplies the place of a harrow. The Hindoos, after depositing the seed in a similar way, use a kind of subsoil plough, which loosens the soil, three drills' breadth at a time, to the depth of about 8 inches. About the middle of the 17th century, Gabriel Platte described a rude dibbling machine, which was formed of iron pins "made to play up and down like Virginal jacks;" and about twenty years later, Worlidge published an account of a seed and manure drill of his own invention, and Evelyn strongly recommended to the attention of Englishmen the sembrador drill-plough which had been invented on the Continent. See the article SEMBRADOR. At the introduction of the drill husbandry under Jethro Tull, that great improver first attempted to revive attention to the sembrador, and next invented sowing machines of his own, and endeavoured to render them fully subservient to his system. "His first invention was a drill-plough to sow wheat and turnip seed in drills three rows at a time. There were two boxes for the seed; and these, with the coulters, were placed one set behind the other, so that two sorts of seed might be sown at the same time. A harrow to cover

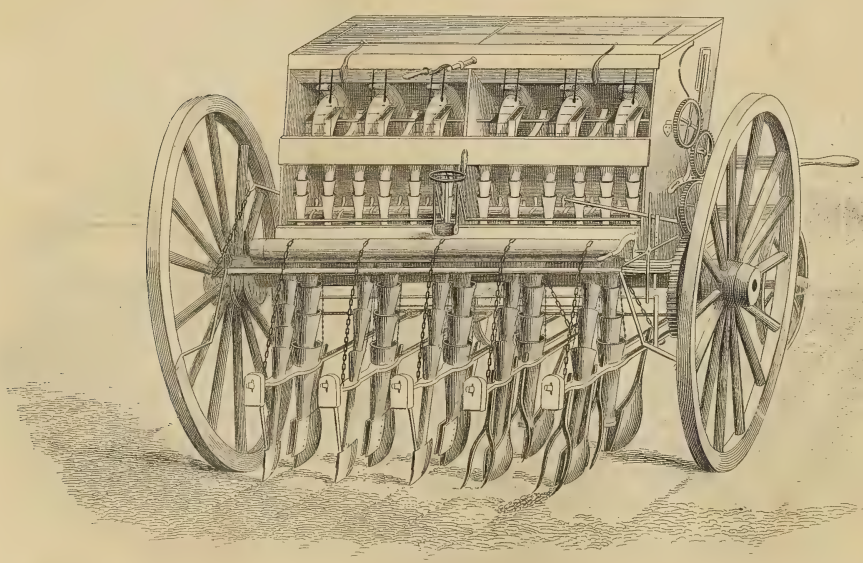
Morton's Drill



Cooke's Drill



Garrett's Drill



Engd by G.H.Swanston Edin.

in the seed was attached behind. He also invented a turnip-drill somewhat similar to the other in general arrangement, but of a lighter construction. The feeding-spout was so arranged as to carry one-half of the seed backwards after the earth had fallen into the channel; a harrow was pinned to the beam,—and by this arrangement, one-half of the seed would spring up sooner than the other, and so part of it escape the turnip-fly. When desirable to turn the machine, the harrow was to be lifted and the feeding would stop. The manner of delivering the seeds to the funnels in both the above drills was by notched barrels; and Tull was the first who used cavities in the surfaces of solid cylinders for the feeding." About the year 1776, Sir John Anstruther, near Edinburgh, invented a one-horse double drill-plough, of simple construction, for sowing two furrows at a time, with the draught-horse walking between them, so that the fine soil was not injured by the animal's feet; and, after eight years successful trial of it, he introduced it to the notice of the Bath and West of England Society. During the next ten years, ten patented machines were invented by distinguished mechanicians or agriculturists for sowing grain or for sowing and harrowing it, and two for depositing manure with the seed; and among these, in 1788, was a drilling and ploughing machine, invented by James Cooke, a clergyman of Heaton-Norris in Lancashire,—improved, two years afterwards, by Henry Baldwin, a farmer of Mendham in Norfolk,—and comprising principles of construction which have been more or less adopted in some of the best drill-machines of the most recent years. The patents taken out for drill-ploughs, sowing-machines, and improvements in drills, since the commencement of the present century, have been very numerous; and the competition in the manufacture of drill-machines among all the good and extensive agricultural implement makers of the present day, is keen and comprehensive, and brings as great a profusion and variety into the market as the most fastidious farmer could well desire.

The chief principles adopted in the construction of most drill-machines, are stated as follows by Professor Low:—"A frame-work is placed upon two wheels; and upon this is an oblong box for containing seeds. From the axle of the wheels motion is communicated to a spindle or axle, which passes horizontally through the lower part of the box; and upon this axle may be fixed, at the distances required, a series of grooved or fluted cylinders. There are apertures formed near the bottom of the box, and as each cylinder revolves amongst the seeds, a certain portion of them is collected in the grooves at each revolution, and is carried round in the grooves and falls through these apertures. By making the grooves larger or smaller, so as to contain a larger or smaller quantity of seeds, or by making the apertures of the seed-box larger or smaller, so as to allow a larger or smaller quantity of seeds to pass through, the machine can be made to sow the seeds more or less thick, as may be required. The seeds, after passing through the apertures, fall into tubes or funnels, through which they are conveyed to the ground. Immediately before the lower part of each funnel is a sharp coulter of iron, which encloses the lower part of the tube, and makes a rut in the ground into which the seeds fall. By these means they are sown in the quantity required and at the depth to which we choose to set the coulters. To allow the rows to be at larger or smaller intervals, the cylinders are generally moveable upon the spindle, so as that they may be set at any distance required, as 9, 10, 12, or more inches. The coulters are made to move at the depth required, and to be lifted up along with the tubes or funnels when necessary, as at the turning at the end of the ridges, the encountering of obstacles, and the like. Sometimes the axle, instead of having cylinders upon it with grooves, has a series of small pinions or teeth. Or, in place of the teeth, there is employed a series of stiff brushes. The teeth or brushes revolve in the same manner as the fluted cylinders, and, by keeping the seeds in motion, cause them to fall through the little apertures or holes near the bottom of the box. The holes are made to be enlarged or diminished by means of a sliding iron plate, placed upon them with an equal number of similar holes with those of the iron-plate. When the holes of the seed-box and the iron-plate correspond, that is, when they are placed exactly one upon the other, the holes through which the seeds drop are of their largest size. But by moving the iron-plate a little to a side the holes do not entirely correspond, and hence the holes through which the seeds fall are lessened; and by moving the iron-plate still further to one side, so as that no part of the two sets of holes shall correspond, those of the seed-box are entirely covered. The iron-plate which thus lessens or closes the apertures of the seed-box, is moved by a lever, and fixed in its position by screws."

Cooke's drill, in consequence of being the sort of type of most of the good modern drills, deserves particular notice, and is figured in *Plate LVII.* "The seed-box is of a peculiar shape, the hinder part extending lower than the fore part. It is divided by partitions, and supported by adjustable bearings so as to preserve a regular delivery of the seed whilst the machine is passing over uneven ground. The feeding cylinder is made to revolve by a toothed-wheel, which is fixed on each end of the main axle, and gears with other toothed wheels on each end of the cylinder; the surface of the cylinder is furnished with a series of cups which revolve with it, and are of various sizes, according to the different seeds intended to be sown. These deposit the seed regularly in funnels, the lower ends of which lead immediately behind the coulters, which are

connected by a beam, so as to be kept in an even line, and are capable of being held out of working when desired by a hook and link in the centre. The seed, as it is deposited, is covered in by a harrow fixed behind. The carriage wheels are larger in size than usual, by which means the machine is more easily drawn over uneven ground; and the labour of working is reduced." The improvements made on this implement by Mr Baldwin of Mendham consisted, "first, in making a sliding axle-tree, by which the carriage wheel could be extended at pleasure to the width of the 'stetches' or lands, and by which means another box with cups and more coulters could be used,—thus a drill containing fourteen coulters could be enlarged to one of eighteen or twenty; second, in making self-regulating levers, to which the coulters were attached,—this was done by hanging each coulter on a distinct lever, placed at right angles with the cross-bar of the framing, upon which each lever was made to swing by an ordinary hinge joint, and had a moveable weight at its opposite end, to press the coulter into the soil. By the levers being thus contrived to work independently of each other, they accommodated themselves to the irregularity of the surface of the land, and the impediments they might meet with, without disturbing the whole. These were two very important improvements; and they are both in use to this day."

The Suffolk drill is a highly improved modification of Cooke's, together with additional apparatus and more extensive adaptations; and it comprises many subvarieties, and is familiar, in some one or more of these, to a large proportion of all the better class of English agriculturists. The forms of it which are based on the improvements of the Messrs. Smyth of Peasenhall and Swefling—two brothers who followed in the tract of Mr. Baldwin of Mendham, and continued to pursue it during upwards of forty years—are the most extensively known, and comprise, in addition to the main apparatus, a contrivance for adjusting the coulters to distances apart from each other $4\frac{1}{2}$ inches and upwards,—a manure-box and cups, for the deposition of special manures along with the seed-corn,—a contrivance for sowing small seeds simultaneously with drilling in manure and seed-corn,—a swing-steerage for enabling the man in attendance on the machine to move the coulters to the right hand or the left, so as to keep the straight and parallel lines for sowing the seeds,—and various improvements in the barrel, the gearing, the wheels, and other parts. "The Suffolk drill," says Mr. Ransome, "is now the kind in the most general use throughout the kingdom, and is adapted for drilling corn either on level lands or on ridges, and on all descriptions of soil. It is furnished with independent levers, by which the coulters are each readily and separately made to avoid any rocks or irregularities of the ground, and a press-bar, extending over the entire width of the machine, to force the coulters, in case of need, into hard ground, with a varying degree of pressure, according to the texture of the soil. The coulters can be set so as to drill the corn at any width, from four inches to a greater distance; they also, if required, readily allow of the introduction of the horse-hoe; and, from being placed in double rows, they admit, when at work, large stones to pass between them of a size that, under the old plan of placing the coulters in one line, would break or stop the machine. The most complete drills are furnished with the 'swing steerage' before referred to, by which the drill-man keeps the rows at exact or even distances from those which have been previously drilled. The 'corn barrel' is made to deliver from two pecks to six or seven bushels, or strikes of seed, per acre; and they are furnished with an additional barrel for drilling turnips and mangel-wurzel. These barrels, by a simple yet efficient 'regulator,' are kept on unequal hilly ground at the same level; so that the grain is evenly delivered, in whatever situation the drill may be placed. The weight of these drills necessarily varies with the number of coulters,—ranging from three to ten cwt. They are drawn, according to circumstances, by one, two, or three horses. The sliding axletree, allowing the addition of any number of coulters, adapts the drill to different breadths of land."

Garrett's drill for general purposes is a highly improved variety of the Suffolk drill, together with additional contrivances for giving it both nicety of execution and a wide range of adaptation. It is well and truly described as follows in the Catalogue of its patentees and manufacturers, the Messrs. Garrett of Leiston in Suffolk; and we need only premise that a picture of the machine is given in *Plate LVII.*, and a copy of the diagram referred to in the description in *LVIII.*:—"In order to render it as intelligible as possible, it may be described, first, as a drill for artificial manures and corn or seeds,—secondly, as a simple corn or grass seed drill,—and thirdly, as a turnip or mangold-wurtzel seed and manure drill. In the first place, it is adapted to drill corn or seeds, with or without manure, in any required quantities, and at any distance apart. Corn may be deposited down separate conductors from the manure, or through the same pipes, either mixing them together, or separating them by a portion of mould being placed between the manure and seed, by rakes, or drags, provided for that purpose. In order that a continued and regular supply of manure may always be falling from the manure box, a double-actioned stirrer is introduced into it, having a perpendicular as well as a revolving motion, by means of which the manure (which in the drills hitherto in use, frequently clogged and hung back in the box, so much so as to require the attendance of a person to prevent it) is constantly disturbed and pressed

forward into the department for the depositing barrel, causing an equal distribution in exact quantities of the most coarse or badly prepared artificial manures, or well rotted farm-yard dung, mixed with a small proportion of soil or ashes. It is likewise desirable to be able to regulate the delivery of manure as the drill travels, as in going over several acres of land, many portions may be found much richer than others, especially in places where the better soil has been washed (by continued wet) off the hills into the valleys. To ensure this variation of delivery, a slide is placed before the mouth of the manure box, worked easily up and down by turning a small wheel at the back of the drill, so that without stopping the progress of the implement, the man in attendance may alter the quantity as occasion may require. The ends of the drill boxes are made of iron instead of wood, allowing the travelling wheels to run half the distance from the outside coulters at which the others are set, and so returning in the same wheel-marks that they made in going the contrary way of the field, to leave the rows all the same distance apart. This improvement extends also to making drills to cover half-rod lands without the necessity of an additional part to put to it in the field; the full spread of the drill wheels outside, being no more than will admit of its passing through gateways of the ordinary dimensions, viz. 8½ feet. The iron cill, or side frame, is much more durable than when made partly of wood and partly of iron, and affords a ready mode of altering the height of the box to receive the different size cog wheels, as the upright centre, upon which the box rests, is raised or lowered by a screw, numbered to correspond with the teeth in the wheels, so that no difficulty can arise in their being adjusted and kept in proper gear with the greatest precision. As a more convenient and easier method for the man in attendance to raise the manure box, when full, in and out of work, a compound lever is applied, by means of which, less than half the power formerly necessary for the purpose will now suffice; the attendant may easily throw both boxes when fully loaded with manure and corn, in and out of gear, as the drill travels.—In the second place, we come to the drill when used simply for corn or grass seeds. When the implement is required for either of these purposes only, the whole of the manure apparatus may be removed, leaving it a light corn and seed drill. The merits and form of the Suffolk corn drills are familiar to agriculturists generally; it remains therefore but to point out the latest improvements which have brought it to its present state of perfection, and classed it among the most complete implements of agriculture. Among these may be enumerated as the principal, the simple apparatus provided to ensure a regular delivery of the seed when going up or down hill. In descending a drill has a peculiar tremor, and a tendency to go faster than when ascending, giving greater velocity to the delivering cups, and consequently throwing more seed down the conductors. To remedy this, and to render the delivery from the barrel as uniform as possible, two cog wheels of different speeds are placed, one on each end of the barrel; either of which may easily be put in and out of gear, as required, and worked from alternate ends,—the small wheel when going up hill, and the large wheel when going down. The seed-engine accompanying this drill is adapted to sow at the same time with spring corn, or may be used as a separate implement for grass seeds broad-cast, or turnips and mangold-wurtzel in rows. In order to ensure an equal delivery of the different kinds of seed, the box is partitioned off into two departments, one for heavy seeds, such as clover, trefoil, &c., and the other for the lighter seeds, such as rye-grass; the former being delivered from cups, and the latter from brushes, down the same conductors with it. Thus the required quantities of each seed are nicely mixed and evenly sown all over the land, and may be regulated by turning the screw at the end of the box for rye-grass, and changing wheels on the cup barrel for clover, &c. By the new steerage machinery which acts as a fore-carriage to the implement, a man may keep the rows of corn perfectly parallel with the preceding course of the drill. This is done by a man holding the steerage handle and keeping the small fore wheels in the tract of the former large one; this, with a little practice, is very easy, and will amply repay, by the perfect regularity in the crop, affording the greatest facility for the horse-hoe going between all the rows of plants, and with equal precision, where the drills join in their different courses through the field. The swing steerage, at a less cost, and managed without an additional attendant, is amply sufficient where the drill covers each stetch, or land, in twice.—Lastly, as a turnip and manure drill, it may be used to suit all methods of cultivation, whether on flat lands, or ridges, as the axle-tree may be made to slip, so as to alter the sizes to the different widths of ploughing. The distances of the rows may be varied at pleasure. The manure is deposited in a continual stream down the large conductors in any required quantities, and covered with the drags, or rakes, with soil to any depth before the seed (which passes through different pipes) is sown upon it; the seed is then lightly covered with mould by chain harrows suspended from the end of each lever. These drills are also made with an addition to drop the manure and seed at intervals, through separate conductors, instead of a continued stream, by means of which, expensive manures may be much economised, one-third, or half the quantity generally used, being by this means sufficient to afford every plant its full proportion of nourishment."

Lord Western's drill is modelled remotely on Cooke's drill, and proximately on the improved

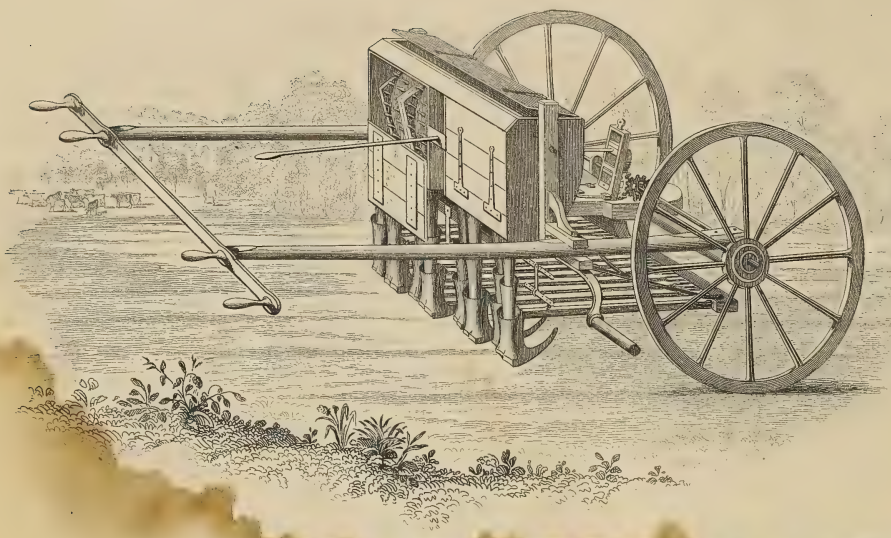
lever varieties of the Suffolk drill; and it comprises improvements for which a patent was taken out in the year 1838. These improvements are, first, the application of improved metallic hinge-joints to the moving levers, so as to ensure their continuing parallel with each other, and in a line with the course of the machine; second, the addition of a pair of thin edged wheels and a fore axle-tree to the machine, by which it can be guided with certainty in any direction; third, a peculiar apparatus for steering the machine, consisting of a shaft passing through a socket, fixed in a plummer-block to the foot-board, its outer end being attached to the fore-axle by a universal joint, the other end having a wheel with handles fixed thereon, by which the machine is readily steered in its course; and fourth, the application of improved iron sockets to the sides of the levers, as a means of fastening the coulters, intead of weakening the levers by passing through them. This implement also admits of horse-hoes being substituted for the drill-coulters; and it performs well the work of horse-hoeing among young plants.

The Scotch drill comprises a number of varieties, differing from one another principally in size, and sowing from five to eleven rows. It is mounted on two wheels, and derives from one o them the motion for turning its machinery of distribution. Its discharging apparatus comprises a line of small thin-toothed wheels, revolving within the seed-chest,—a series of orifices beneath the wheels, for allowing the seeds to drop through which are brought down by their revolution,—and a number of tubes, corresponding to the number of rows which the machine can sow, for catching the seeds from the orifices, and conveying them down to the chambers of the coulters. A chain passes from the horse-shafts under the seed-chest to the hind-bar, and is there hooked or let go by the conductor at pleasure; and this assists him to keep the coulters in the ground. A marking-bar is attached to the machine, and traces a streak in the soil; and along this streak the horse is made to walk in the returning bout in order to equalize the interval between the bouts. Except in cases where the whole field is tilled quite flat, this machine, in consequence of the coulters being fixed, is best adapted for sowing across the ridges. The varieties of it which have only five or six tubes are drawn by one horse; and those of larger size are drawn by two.

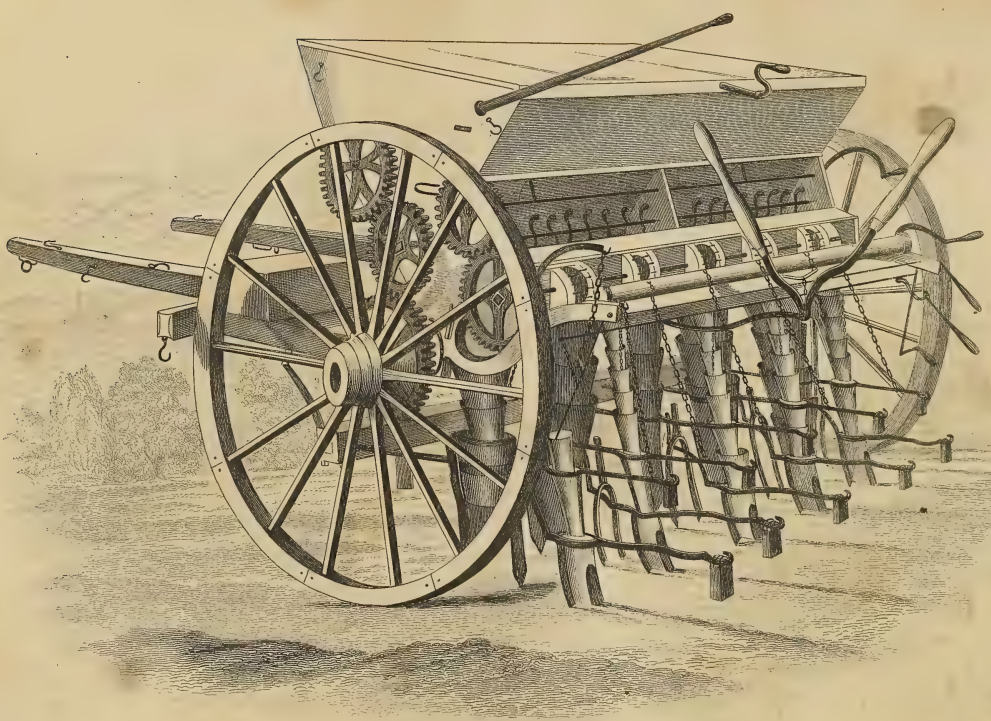
Morton's drill was invented about the year 1828 by Mr. S. Morton of Edinburgh. It is one of the simplest and cheapest of the corn-drills, and at the same time may bear comparison with the best. A figure of it is given in *Plate LVII.* It has a large wheel, with an universal joint; and is fitted with brushes and shutters. "Three hoppers are included in one box; and the seed escapes out of all the three by the revolution of three seed-cylinders upon one axle; and drills of different breadths are produced simply by the shifting of a nut that fixes a screw moving in a groove in the under frame, by which the distance between the two outside conductors and the central one (which is fixed) can be varied from 9 to 10 or 11 inches; and that the two small wheels may always be at the same distances respectively as the conductors, there are two washers (hollow cylinders), an inch in breadth, on the axle arms of each, which may be transferred either to the outside or inside of the wheels so as to make their distances from the outside conductors 9, 10, or 11 inches respectively also. The small wheels may be raised or depressed, so as to alter the depth, at which the seed shall be deposited, by the action of a wedge, which retains the upright part of the axle in any one (at pleasure) of a number of notches, which are made similarly in both, and which are caught by an iron plate on the upper side of the arms which carry the axles. This machine may be still further improved by increasing the number of conductors to five, instead of three, the latter number giving too light work to the horses."

The Bedfordshire drill is a simple and ingenious machine, and possesses an eminently advantageous arrangement for the directing of its motion and the controlling of its work. A figure of it is given in *Plate LVIII.* It was invented by Robert Salmon of Woburn; and obtained about thirty-five years ago the premium at the Duke of Bedford's annual sheep-shearing; and it was afterwards improved, first by two brothers of the name of Bachelor, at Lidlington, in the vicinity of Bedford,—and next by several of the present manufacturers of it, particularly Hensman of Ampthill, Hensman of Woburn, and Smith of Kempston, in Bedfordshire. "The seed-box," says Mr. Ransome, "is suspended upon two centres, one at each side; on these it swings so as to keep its level position as the drill moves up and down hill, or over ridges. Sometimes, instead of the box being made to swing upon centres, it is fixed so as to be altered, as occasion may require, by an adjusting screw and crank placed in a convenient position for the drill-man to regulate. The seed-corn is taken up by iron cups fixed on circular plates and delivered into funnels, from whence it descends to the ground; these plates are centred upon a spindle, which revolves by being connected with the nave of one of the carriage wheels. The coulters are forced into the land by an equal pressure upon each from the centre of the carriage, on which nearly the whole weight of the drill rests. The steerage is effected by a pair of light wooden bars, attached to the axle on which the carriage wheels run. These have a cross bar at their ends, to which small handles are attached, so that the man may guide the drill to a nicety, whether he be at the right or left side of it. Drills on this principle of steerage are made with four, six, or eight coulters; the two larger sizes are in general use in Bed-

Bedfordshire Drill.



Garretts New Drill (with Manure) for Turnips or Mangel-Wurzel.



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fordshire: those with six coulters are considered the best for heavy or hilly land; those with eight coulters for light and level lands. The Bedfordshire drill, which has been thus described, is an exceedingly useful little machine for sowing corn; but it is not suited for the combined purpose of sowing manure and corn at the same time, as the weight of the additional box, when first charged with manure, would be so great as to press the coulters much deeper than is advantageous for depositing the seed, and when nearly emptied, the converse would probably be the case. The total weight of the machine, with the additional loaded manure-box, would also render it unwieldy for a man to turn at the ends of the land. Robert Maynard, of Whittlesford, Cambridgeshire, an ingenious mechanist, to whom the agriculturists are indebted for several improvements in drills and other machinery, has, by the simple contrivance of placing a roller immediately in advance of each coulter, remedied this defect, as these rollers not only prepare the surface of the soil for the most favourable operation of the coulters, but at the same time secure their penetrating the ground to a uniform depth. In his drill the seed-box is a small compartment in the manure-box; its total weight, when loaded with about five bushels of manure, the quantity it is calculated to hold, is not much more than that of an ordinary corn-box; and by placing it somewhat more in advance than the common seed-box, the operator is relieved from any undue weight, which is thus thrown upon the wheels."

Grounsell's drop-drill was patented in June 1839. It deposits seed-corn or pulse-seeds and manure at intervals in drills, and can be made to vary the distances between the intervals at pleasure. A circular iron-ring is fixed about midway between the nave and the rim of the carriage wheel; a number of holes in this ring carries a series of studs, which may be varied according to the length of the desired intervals; and the valves for the delivery of the seeds and the manure are opened by the successive studs in revolution, and immediately shut again when each stud passes. The seeds and the manure, also, are worked into the funnels, not as in other drills with cups, but with projecting arms or shovels.

Hornsby's drop-drill was patented in November, 1839, and performs the same kind of function as Grounsell's, but with a widely different mechanism. "The manner of regulating the delivery is by having a coulter of a peculiar form inside, in which a circular box revolves on an axle which passes through one side. This box is divided into compartments closed by small doors, which are kept shut by a spring to each; the compartments in the box are supplied through a series of funnels, the end of the lower one entering one side of the box below the centre. On the machine being moved forwards, this box revolves by means of appropriate cog-wheels; and as each spring arrives at the ground, the door to which it is attached opens, and the contents of that compartment are deposited, to be again replaced when it arrives at the part of its rotation at the end of the funnel, and so on successively."

Garrett's drop-drill is a modification of the drill for general purposes, so constructed as to deposit seed and manure at intervals on ridges or flat ground; and—as well as the general drill—it comprises a number of sizes and varieties. "The merits of these drills," say Messrs. Garrett, "are important in economizing expensive manures, as one-third of the quantity generally used will now suffice for the crop. By this novel and effectual contrivance of dropping the seed and manure in heaps, at intervals, every plant is nourished with its full proportion of the manure. Prior to our invention, no drills were made but what deposited in a continual stream, or dropped the seed and manure out of the pipes together mixed in one heap, so that when strong manures were used, they were almost certain to spoil the germ of the seed, and prevent its vegetating, thus offering at once a great and fatal objection to their use. To remedy this our present patent has been taken out, and is for correctly dropping the manure and seed separately at any required intervals, so that in one process the manure is dropped at intervals, at any required depth below the seed and covered with mould; then follows the seed-conductor, and lodges in any minute quantity patches directly above the manure, leaving a small portion of mould between them. By the new steerage machinery which is applied to these drills, and which acts as a fore-carriage to the implement, a man may keep the rows of corn perfectly parallel with the preceding course of the drill; this is done by the man holding the handle and keeping the small fore-wheel in the track of the preceding large one; this, with a little practice, is very easy, and will amply repay by the regularity afforded to the crops, besides the facility it affords for the horse-hoe going between those rows of plants where the drill joins in its different courses through the field." The figure of the drill for general purposes in *Plate LIX.* represents that drill set for turnips, the two levers on the right hand being to drop the manure and seed, and the three on the left to drill them in a continual stream,—and it is shown in these two ways in order to illustrate more clearly the merits of their respective plans; but, of course, when the implement is in use, all the levers are either used to drop, or all to drill in a line.

Rham's sowing-machine—invented by the late Rev. W. L. Rham of Winkfield, and patented in November, 1841—is rather a dibbler than a drill; yet it is suited alike to wheat and pulse and some other crops, and was designed by the inventor so to drill and dibble seed upon flat and well-prepared land that any field sown by it, no matter how extensive, should present the neatness and regularity of a highly finished garden; and it is

therefore well entitled to notice in this place. The judges at the Royal Agricultural Society's show at Liverpool in 1841, spoke of it "chiefly in its capacity of a dibbler of seed and manure," and reported upon it as follows:—"The operative part of the machine is suspended upon an iron carriage having four wheels, the two hinder ones being fast upon their axle and turning within it. On this axle is a spur-wheel, giving motion to a pinion on an intermediary axle, which carries a wheel geared into a second pinion fixed on its axis, having six cranks arranged spirally. The velocity given to the axis is such that the cranks make one revolution for every six inches of the circumference of the hind wheels, or whatever is the distance desired between the dibble-holes. The radius of each crank is such that this distance shall be equal to the circumference described by one revolution. Thus the space described by every crank coincides with that passed over in the same time by the hind wheels; and as the cranks turn, during the half of a revolution, in an opposite direction to that of the wheels, the result of this compound motion is a pause or rest of short duration, at the point where the crank in its rotation commences to retrograde from the line of progress of the machine, *i. e.* at the lowest point, and when the dibbles are in the ground. The crank raises the dibbles up and down by means of connecting rods and levers, which double the vertical without increasing the horizontal motion; and in order that the point when in the ground, may be perfectly stationary, it is made the centre of motion while the machine progresses; and to enable it to retain that position for a sufficient length of time for the purpose of leaving a hole truly vertical, the dibbles move between checks in the rod which connects it with the crank, and which has a spring to restore it quickly to its proper place as it rises out of the ground. During therefore the entire time occupied in its piercing the hole and being withdrawn from the soil, the dibble retains its perpendicularity. By an ingenious and simple contrivance, a slow rotatory motion about its own axis is given to the dibble, by which means its point may be said to bore into the ground, thus assisting in the formation of the hole; and by the same action the dibble is cleared of any adhering soil, and the hole left firm and clear. The seed-valve consists of a cylinder, with a cavity in it of dimensions sufficient to hold one or more seeds. This cylinder is tumbled over, and the seed discharged into a recipient of the shape of a quadrant, from which it is pushed out, when the cylinder returns to its first position and takes in a fresh supply. As this motion is sudden, the seed is surely delivered, even when rather damp: when the cylinder is delivering, the quadrant is receiving, and *vice versâ*. The delivery of manure is effected by a similar apparatus, only of a larger size, the valves being furnished with brushes or other means to remove the superfluity. The valves are connected with the dibbles in such a manner as to deposit the manure and seed in the hole last formed, whilst the dibbles are stationary in the advancing one. The dibbles bore their holes in shallow drills made by the pressure and sliding action of an iron shoe shaped like a boat, and forming a smooth furrow. The whole of the machinery is supported by an iron frame, one end of which rests on trunnions attached to a projecting part of the back of the carriage. It is suspended at the other end by a cross shaft carrying two pinions, working in arcs of circles fixed on the frame, so that it can be raised or depressed at pleasure, or elevated clear of the ground by one turn of a winch. At the same time, the pinion connecting the machinery with the hind wheels is put out of gear, and the whole can be moved about on the carriage. The implement is steered in a manner somewhat similar to Lord Western's drill." See the articles DIBBLE and DIBBLING.

The broadcast sowing-machine, in one of its most improved forms, for sowing seeds of corn and grasses, is described in the article BROADCAST SOWING. This machine is not much used in England, but is extensively and increasingly used in the best arable districts of Scotland. Its great recommendations, which give its work a preference to hand-sowing, are the saving of seeds, the regularity and certainty of their deposition, and the prevention of all the bad consequences of unskilfulness or carelessness or conflicting with the wind on the part of a hand-sower. The first broadcast sowing machine ever known in Scotland was introduced in 1816 from Yorkshire; and the first ever manufactured in Scotland was made in 1817 by Mr. Lowrie at Edington in Berwickshire. "In the early application of the broadcast machine," said Mr. Slight in 1844, "it was mounted on two wheels; but a few years experience pointed out the advantages of a third wheel, which was applied to it by Messrs. Scouler of Haddington about the year 1830, the third wheel being applied as a swivel or fore-carriage. The carriage is still subject to considerable variety of construction; but these varieties are not of a nature to alter its general character. A carriage of nearly triangular form is very generally adopted, the apex being in front over the swivel-bar. A rectangular carriage is also very much employed; and this is the most workmanlike construction, though perhaps not the cheapest, but it is withal the most convenient and useful form. As regards the general construction, an important improvement has been introduced within the last six years; this is the cutting of the seed-chest into sections. The chest is usually made 18 feet long, which being far beyond the width of any field gate, produced a necessity for changing the position of the chest when passing through a gateway. It was therefore the practice to lift the chest from its working position parallel to the axle of the machine, and deposit it parallel to the horse-shafts until it had passed through the

gate. This was clearly both imperfect and inconvenient, and these defects gave rise to the cutting into sections, the middle part being 9 feet, and the extremes each 4½ feet, so that when the latter are folded up, the extreme length of chest is 9 feet."

Dudgeon's sowing-machine was invented about twelve years ago, by Mr. Dudgeon of Broomhouse, East Lothian, and is an amplification of the broadcast machine with additions of roller and harrow to perform the processes of sowing, rolling, and harrowing grass-seeds at one operation. The fore and hind bars of the top frame have a length of about 7 feet 4 inches, and are set at the distance of 2 feet apart. The horse-shafts are bolted down to these bars, and have the same length as any ordinary horse-shafts, but are prolonged into extension-bars, which are bolted to their ends. The seed-chest occurs first, the roller next, and the harrow last. The seed-chest has a length of 6½ feet, and is appended to the lower side of the horse-shafts, immediately in front of the fore-bar, and may be fitted up in all respects similar to the common broadcast seed-chest, the spindle which carries the small discharging toothed wheels being put in motion by a belt or a chain passing over a pulley, 12 inches in diameter, on the projecting end of the spindle; the belt or chain receiving its motion from another pulley of 9 inches diameter, placed on the axle of the roller. The roller is also 6½ feet in length, and is about 18 inches in diameter, though this is not imperative, nor is the material of any essential importance. It is supported by its journals in two semicircular bars of malleable iron, or of cast iron, bolted to the extremities of the fore and hind bars. From the semicircular bars proceed also two stays for the further support of the seed-chest. The harrow is suspended immediately behind the roller. It consists of two frames, each 3½ feet in length, and 1 foot in width, which are jointed end to end, and form a harrow 7 feet in length, with only two rows of tines. The tines are set at 2½ inches distant; and, as those of the one row alternate with those of the other, they make a rut at every 1¼ inch. The direct suspension of the harrow is effected by means of chains from a moveable bar which, being jointed at one end, is capable of being raised aloft from the horizontal position to any requisite or desirable point of elevation, and retained there by a pin passed through a quadrant over which the bar moves; and by this means the harrow is regulated as to depth,—while by means of a link from the semicircular bars, and by a chain from the extremity of the extension bars, it is duly stayed in a proper position, and at the same time has sufficient freedom of swing to ensure its useful effect. A joint at the middle of the harrow allows it to accommodate itself to the rounding of the ridges when required; and a lever in the middle of the top frame is, through its connexion with another lever on the back of the seed-chest, used for opening and shutting the orifices, and for regulating the discharge of the seed, by moving a long slide plate in the usual manner.—Fullarton's sowing-machine also performs the whole process of depositing grass-seeds at one operation; and it differs from Dudgeon's only in the arrangement of the parts,—the order of its processes being rolling, sowing, and harrowing.

Turnip drills exceedingly vary in size, structure, and complexity. Some are small hand barrows, and others are large horse-drawn machines; some are the simplest of all sowing machines, and others are nearly or quite as complex as the most elaborately constructed grain drills; some sow only single rows, and others sow two rows, or several, or many; some sow in continuous streams, and others at intervals in the drop manner; some sow only seeds, and others both seeds and manure; some are suitable only or chiefly for turnip-seeds, and others are suitable also for corn seeds, grass seeds, or other field seeds. One class have grooved cylinders, with a size and a mode of action suited to the minuteness of the seeds, and make their depositions through tubes defended at the point by rut-making coulters; another class have revolving cylindrical boxes of iron or tin, perforated in a line all round for the passage of the seeds, and sheathed in an iron or tin plate, also perforated with sets of holes, and capable of such slight shifting of position as to regulate the amount of discharge; and a third class imitate the peculiarities or aggregate structure of some of the best large grain drills, of which, in some instances, they are mere modifications.

The common drill-barrow is a small light wheel-barrow, driven by hand, and sows turnip-seeds or other small seeds in a single row. The seed falls from the seed-box on a wooden or metal cylinder below, and is regulated, in the quantity of the fall, by a slide in the box; it afterwards lodges in several cavities in the circumference of the cylinder, and passes down thence into a tin funnel below; and it is made to descend in an uniform stream by means of small brushes in which the cylinder turns. The motion is communicated from the wheel to the cylinder by a chain on two pulleys placed on the axes.

Bennet's turnip and grass seed sowing-machine has a long box fixed transversely on a barrow, and connected by light gear-work to the barrow-wheel. In the box are a number of brushes fixed on a spindle, and running the whole length, which revolve, as the machine progresses, against perforated plates of copper, and carry with them the seed in such quantities as the operator desires or has set the regulating plates to let pass.

The one-horse, two-row turnip-drill is the machine most extensively used for sowing turnips in the best arable districts of Scotland. It moves on two concave rollers, generally of cast-iron,

which serve both to consolidate the drill and to give motion to the seed barrels; and they are self-adjustable to the width of drill by sliding on their own axis. The seed barrels are made of tin, and have small orifices of three sizes for discharging the seed; and the tubes which receive the seed from the orifices terminate in the chamber of the coulters, and deposit the seed in the ruts which the coulters form. Two small rollers are occasionally used, attached to the seed-box frame, for covering the seed.

Geddes's turnip-sowing machine is an improved form of the one-horse two-row turnip-drill. It was invented by Mr. Geddes of Cargen-Bridge in Dumfries-shire, and was first exhibited in 1837. A figure of it is given in *Plate LIX.* The improvements occur, not in the general construction of the machine, but principally in the substitution of a seed-box and distributing roller for the tin-plate seed-barrel, and in the communicating of motion from the rollers in which the machine moves to the distributor. The horse-shafts are bolted down at their hinder end upon a bed-plank; the handles also are jointed to the bed-plank, and can rise or fall within the guidance of sheers affixed to its hind edge; and two inverted standards are attached by bolts to the ends of the bed-plank, and connect it with the travelling-axle. The curved rollers, on which the machine travels, are, as in the common two-row turnip-drill, 16 inches in length, and 14 inches in diameter at the ends, and diminish to 8 inches in the middle; and they consist of cast-iron, with cross arms at each end, and have a rod or axle, common to both, passing through them and the standards. A pendant iron V-stay supports the middle of the axle; and the length of the bed-plank and the axle is such as to afford space for the rollers to shift to right or left, accommodating themselves to the varying width of the drills. The seed-box frames are also appended to the axle, and move laterally with their respective roller; and the seed-boxes are placed on a small platform attached to the arms of the frame. The motion which the rollers acquire by the travelling of the machine is communicated to the seed-distributor through trains of small wheels; and these are enclosed in a case, to prevent earth from falling into their teeth; and the first wheel of each train is connected with the end of its roller, and the last is placed upon the axis of the distributor. Small rollers are attached to the frames, similar to those which are used in the common two-row turnip-drill, for the purpose of giving a slight cover to the seed; and here they serve also as regulators of the depth to which the seed rut is formed, and therefore they can be raised or lowered by shifting their axes, and are provided with scrapers to remove any adhering earth. The seed-box frames are attached to the handles by a chain; and by means of this, they can be lifted from the ground at pleasure. The seed-box is a bowl of 7 inches in diameter and 5 inches in depth, and opens at the bottom into a space which is filled with the distributing roller. This roller is of brass, and about $1\frac{1}{2}$ inch in diameter, and has a groove of one-tenth of an inch wide running round it. A slider has a tongue adapted to fit into the groove, and is fixed by means of a screw to suit any required quantity of seed that it may be desirable to sow per acre,—the quantity of seed distributed being proportioned to the extent of opening left between the point of the tongue and the bottom of the groove.

The two-row turnip and bone-dust sowing-machine makes a simultaneous deposition of the seed and the manure, and is used in the best arable districts of Scotland. It is drawn by one horse, and has the distance between the coulters regulated by hand-gear. It is mounted on two wheels, which serve to turn both the seed and the bone-dust apparatus. The former consists of the common tin seed-barrels; and the latter comprises two wooden hoppers, with each an enclosed wide-toothed or notched wheel, whose revolving motion discharges the bone-dust contained in the hopper into a tube which terminates, in common with the tube from the seed-barrel, in the chamber of the coulter. The regulation of the discharge of the bone-dust is effected by means of a slider which enlarges or diminishes the passage from the hopper.

Nicol's turnip and bone-dust sowing-machine is one of the oldest combinations of mechanism for simultaneously depositing the seed and the manure; and it considerably resembles the common two-row turnip and bone-dust sowing-machine in general structure; but it has a different arrangement of parts, and different modes of communicating the motions. It travels on one large roller and on a fore-wheel without a swivel-bar; and the former gives motion to the sowing apparatus; and the adjustment of the coulters is not self-acting, but is effected by hand-gear.—Hamilton's turnip and bone-dust sowing-machine possesses the same properties as the preceding, but is differently arranged.

Crosskill's improved turnip and manure drill is made of two kinds,—the one for sowing one drill and the other for sowing two drills. It sows, in rows 24 inches apart, quantities of seed, graduated by the number of cogs upon a regulating wheel, from $1\frac{1}{4}$ to $2\frac{3}{4}$ lbs. per acre; and it sows, with the same cups, from 20 to 40 bushels of bones or other pulverized manure per acre. By drawing the box with the iron lever fixed to it to the hindmost part of the drill, it sows more, —and by drawing it forward, less; and a slide in the box is also drawn up or down to assist in depositing the quantity required. The iron lever on the side of the machine is likewise used to throw the wheels in or out of work.

Garrett's lever ridge-drill for turnips or mangel-wurzel with manure is made with two coulters, and is intended for ridge ploughed lands,

having the same improvements and advantages, in the manure department, as Garrett's drill for general purposes, with the improved slides to regulate the quantity of manure placed directly under the management of the attendant who follows the drill, and may be altered while the implement is proceeding in its work, admitting larger or smaller quantities, as may be required on hilly lands, or various qualities of soil. In order to accommodate the drill to irregular ploughed ridges, a pair of rollers are attached to a fore carriage, so as to form and press the land properly for the deposit of the manure and seed; and what has hitherto been found a difficulty, of keeping the depositing coulters on the top of the ridges, is remedied in this, by the levers being easily steered by a parallel movement, so that the seed coulter advances in the exact line of the manure coulter. The rakes add greatly to the effective working of the drill,—those foremost filling up the channel left by the large manure coulters, and thus permitting the seed coulter to make its work in fresh stirred mould, directly above the manure,—and the latter rakes will sufficiently cover the seed, leaving a slight dip for retaining the smallest quantity of moisture.

Garrett's lever drills for turnip, mangel-wurzel, and other seeds with manure may be used to suit all methods of cultivation, being made to work with any number of levers, having axletrees to slip, so as to alter the sizes to the different widths of ploughing, and parallel swing or fore carriage steerages, enabling the man in attendance to guide the coulters or drill, without depending on the driving of the horses. On stetch or broad work, the rows of seed may be deposited from 12 inches to any wider space. In these drills the turnip and mangel-wurzel seeds are taken up separately by the cups, but deposited together down the conductors, so as to prevent any unequal mixture of the seeds. The novelties and improvements in the manuring machinery are the same as in the drill for general purposes, with the manure box and apparatus made large, for depositing any quantity of every kind of artificial or well rotted farm-yard manure.

Crozier's turnip-sowing-machine, with apparatus for depositing liquid manure with the seed, was invented nearly thirty years ago by Mr. Crozier of Alnwick. It differs little in the construction of its sowing part from the common two-row turnip-drill; but is distinguished by carrying a liquid manure cistern, fitted with cocks and tubes, by which the liquid can be deposited along with the seed.

M'Naughton's sowing-machine for carrots and turnips was invented in 1833 by Mr. M'Naughton of Irvine. It is intended principally for sowing carrot; and the seed-distributors are accordingly adapted to separate and discharge that peculiarly adhesive seed. This is performed by the revolution of small spiked wheels in each seed-box, aided by a separate and smaller wheel of the same kind revolving in the orifice of the seed-box. By a slight change in the distributing apparatus, the machine is converted into an efficient turnip-drill.

Liston's turnip drop-drill was invented in 1835 by Mr. Liston of Blairgowrie. Instead of sowing continuously, this machine was intended to deposit a portion of seed and manure together, at stated intervals, whereby a saving might accrue, both in the seed and manure, and the first thinning of the braird might be dispensed with. The construction of the machine differs both from previous turnip and bone-dust sowers, except in the depositors; these consist of a short double conical roller, which forms the groove or rut, in a continuous form, for the reception of the seed and manure, and this followed by a short cylinder, partly incased in a cover. The cylinder is chambered on the periphery; in these, certain quantities of the seed and manure are collected; and as the cylinder revolves and the machine progresses, these little collections are discharged at the proposed distances. In practice, however, it was found that the chambered cylinder did not deliver its contents at intervals, but nearly uniform, except when the machine travelled so slow as to be ineffective.

Nicol's turnip and bone-dust drop-drill was invented by Mr. Nicol of Guildy in Forfarshire in 1840. Its construction is nearly the same as that of Liston's, except the dropping apparatus. This consists of a raised fillet encircling the front rollers, and having also obtuse dibbles proceeding from it at nine-inch spaces, which, while the roller levels the top of the drill, forms also a smooth channel, with dibble holes at nine inches apart, along its surface. Into this channel the seed and bones are deposited continuously; but an iron instrument or scraper follows close behind, having a protuberance that follows in the channel of the drill; this member sweeps the bones and seed before it till they fall into the first dibble-hole, and so on.

The common bean-drill sows only one row at a time, and is mounted like a wheel-barrow, and is so light as to be easily pushed forward by the hand. A groved cylinder works in the bottom of its seed-box; and at each revolution of the cylinder, a quantity of seeds, dependent on the size of the grooves, is carried round, and falls into a tube at the bottom, and is conveyed through this to the ground. Motion is conveyed to the cylinder from the barrow's travelling wheel by means of cranks.

The bone-dust sowing-machine is employed for depositing bone-dust or other granulated manures in drills, and is adapted to serve three drills at each turn. The bone-chest is mounted on two wheels, one of which gives motion to the three distributing wheels placed inside the chest; the revolutions of the latter give out the manure to the sheet-iron tunnels, which deliver it into

the furrows previously prepared by the plough. The quantity to be discharged is regulated by sliders which lie over the orifices. In depositing manure by this machine, it is laid in the furrows between the first-formed drills, and is then covered up by passing the plough along the drill and cleaving it. After this operation, the seed is deposited by the common turnip sowing-machine. The bone-sower may be drawn by one horse.

The English manure-drill is a moveable, facile, and very efficient appendage to the common lever corn-drill; and can at any time be adjusted, and put into working trim, by any husbandman. "It is," says Mr. Ransome, "a simple yet accurately-working apparatus for delivering the manure,—which, in the best drills, it does with great evenness, and in quantities varying, as 'the slip' is placed, from six to eight bushels per acre. In the best-drills, also, a very important improvement has been made within the last few years, which consists in the use of separate coulters for manure and seed. The manure is now deposited according to the mode preferred by the cultivator, not only from two to three inches deeper in the ground than the seed, but from ten to twelve inches in advance of it, so as to give the soil time to cover the manure before the next coulters deposit the seed." This improvement exists in all its amplitude in all Garrett's seed and manure drills.

Crosskill's improved portable manure-drill is a one-horse skeleton cart, surmounted by seed-box and sowing-gear. It serves for sowing soot, salt, guano, and other special manures. It is six feet wide, and contains eight bushels of manure, and sows a comparatively great or small extent of land per day according to the speed of the horse. The acreable quantity sown is regulated by the position of the seed-box and the extra cog-wheels; for according as the box is placed toward a vertical or toward a horizontal position, the quantity per acre is increased or diminished.—*Ransome's Implements of Agriculture.—Gray's Implements of Husbandry.—Catalogue of the Highland Society's Museum.—Catalogues of Garrett, Crosskill, and other principal Implement-Makers.—Annual Register of Agricultural Implements.—Slight's Descriptions of Implements in Stephen's Book of the Farm.—The Society of Gentlemen's Complete Farmer.—Low's Elements of Agriculture.—Rham's Dictionary of the Farm.—The Bath Papers.—Quarterly Journal of Agriculture.—Transactions of the Highland Society.—Journal of the Royal Agricultural Society of England.*

SOW-THISTLE,—botanically *Sonchus*. A diversified genus of plants, of the succory division of the composite order. Four species grow wild in Britain; upwards of twenty have been introduced from other countries; a number of uninroduced exotic species are known; and nine or ten species which recently ranked as sow-thistles are now assigned to other genera. Seven of the introduced species are ornamental, greenhouse, yellow-flowered, evergreen shrubs, of from 2 to 5 feet in height; eight or nine are ornamental herbs, some annual, some biennial, and some perennial, all with runcinate or lyrate leaves, and most with yellow flowers, and about 2 or 3 feet in height; one is a handsome, hardy, perennial-rooted herb, with entire leaves and yellow flowers; and three are respectively annual, biennial, and perennial herbs, with pinnatifid leaves and weed-like appearance.—The stems of the four indigenous species are hollow; the leaves are runcinate or lyrate, and have toothed or prickly edges; the inflorescence is hairy or glandular; the flowers are yellow; and the whole herbage is smooth without, and has a bitter white juice within.—The potherb species, or common sow-thistle, *Sonchus oleraceus*, is one of the most generally diffused of our annual weeds, and abounds in multitudes of fields both waste and cultivated. It has commonly a height of about two feet, and blooms from June till August. Its roots are milky and bitter, but have occasionally been converted into bread; and its leaves are greedily eaten by hares and rabbits, and are sometimes dressed and eaten in the manner of culinary herbs.—The rough species, *Sonchus asper*, is also an annual weed of our fields, and is similar in height and bloom to the common species.—The corn-field species, *Sonchus arvensis*, is a perennial-rooted weed of our corn-fields, and has a height of about 20 inches, and blooms in July and August.—The marsh species, *Sonchus palustris*, is a perennial-rooted indigen of the river-banks of some parts of England, and has commonly a height of from 5 to 8 feet, and blooms in July and August, and makes an interesting and even handsome appearance.

SOY. See Soja.

SPADE. A hand implement used for digging. It comprises a number of varieties; yet, even inclusive of these, is everywhere so well known as not to require any description.

SPADE HUSBANDRY. The cultivation of land by means of the spade, either without the plough or along with the plough. Spade husbandry without the plough is practised in kitchen gardens, in allotment plots, in cottier farms, on rocky grounds, on precipitous banks, and in all other circumstances of tillage where the introduction of the plough is impracticable or uneconomical. The superior power of it to ploughing, on almost all varieties of land of the same natural depth and character as that of ploughed fields, is well known to all classes of cultivators; and consists in greater depth of tillage, in opening a far wider scope for the varying and ramifying of the roots of plants, in effecting a far fuller degree of every kind of subsoil stirring, in rendering the whole soil much more pulverulent, friable, and mellow, and in avoiding all the bad effects of the tread of the feet of horses, and of the pan-forming action of the sole of the plough.

Spade husbandry in conjunction with ploughing makes fully as much use of the three-pronged fork as of the spade, and deals more directly with the subsoil than with the soil, and possesses perfect adaptation to extensive fields and farms, and is capable of great achievements in the way of improving the tilth and produce of much valuable land which maintains a mediocre and stationary character under the action of horse-drawn implements. We cannot better illustrate these points than by presenting an abstract of a recent paper on the subject from the pen of Mr. Cuthbert W. Johnson. "The subsoil plough, to which such an impetus has been given by Mr. Smith of Deanston," says he, "has been tried in much too careless a manner, and with too little discrimination, for it to be universally popular. Its effects, too, on many soils with stiff clay substrata, are neither remarkable in extent nor soon apparent. On such land the subsoil is not sufficiently broken, the earth merely rising or swelling in the trench, and speedily settling to nearly its former firmness. On such soils the spade, or, what is infinitely better, the fork, generally produces much better effects — the soil is more broken, and the subsoil better interspersed with small cavities, to which the air penetrates, and through which the superfluous water of the soil escapes, and the roots of the cultivator's crops extend with greatly increased facility. The rain gradually sinks down to the whole depth of the porous substratum, and from thence to the furrow drains; and, in time of great drought, the deep-moved ground will hold, by capillary attraction, a much greater supply of moisture for the nourishment of plants; so that thoroughly deepening and loosening the soil, not only assists the escape of the superabundant water during heavy rains, but it affords additional means of supplying healthy vegetation with moisture at those times when it is most needed.

"An experiment in fork-husbandry, on a bold scale, was commenced some time previous to 1837, by Mr. Mitchell, in the parish of Wymondham in Norfolk,—and was reported by the late Dr. Yelloly to the British Association; and that portion of his remarks which alludes to the results obtained I will give in this paper, since it answers very completely certain practical questions as to the working of the fork-husbandry which are sure to be proposed by those who have not witnessed the working of the system. The farm of Wattelfield, on which the experiment was conducted, consists of about 317 acres, of which 207 are arable, and 110 in pastures and plantations. The digging was at first carried on with the spade, but this was speedily exchanged for a strong three-pronged fork, of 14 inches deep, and 7½ inches wide, which is found to be more manageable and less expensive than the spade. This fork cost 4s. 6d. instead of 6s. 6d., weighed 8 lbs., and, when worked down, could be relaid at a trifling expense. The digging is effected by taking in about 4 inches of earth at a time, pressing perpendicularly, and getting to a proper depth at two thrusts. The earth, however, is not turned out of the trench to a greater depth than ten inches, although the fork may get down as far as 13 or 14, but that which remains at the bottom in the state of what is called 'crumbs' answers the purpose equally with the earth which is thrown out, of forming a permeable medium for the roots of the plant which is to grow in it. The men prefer working together, in order that their labour may be, as nearly as possible, on the same description of soil; but each takes in about 9 feet in width, so that his work can be easily measured. The plan is to have a breathing about every half hour, and the men never work more than the regular ten hours per day. Digging is, however, more laborious than the usual operations of agriculture, though it is much less so with the use of the fork than when the spade is employed. The labourers work the land in ridges of about 9 feet in width; and the furrows dividing them are sometimes made by the plough previously to the digging, and sometimes by the management of the labourers. The men receive for the ordinary digging after a white crop from 2d. to 2½d. per rod, of thirty square yards, the price varying according to the tenacity of the soil. Where the land is to have a fallow crop, such as turnip, mangel-wurzel, or cabbages (for no part of the farm or the land in the immediate neighbourhood has ever a naked fallow), there is first a ploughing, which is done at a season when the horses can be best spared, and afterwards a digging at from 1¾d. to 2d. per rod. In preparing for a fallow crop, there is also an expense incurred in harrowing and in raising a ridge with the plough, which last is worth about 7s. per acre. The men are paid the usual wages of the neighbourhood at harvest; but as the whole number ordinarily employed are not required at that period, those for whom there is no occasion disperse themselves amongst the neighbouring farmers, with the understanding that they may resume their employment when harvest is over, which they are always happy in doing. The ordinary earnings of a labourer in digging are from 11s. to 12s. per week. It is to be noticed that Mr. Mitchell has always ploughed clover lay for the succeeding crop, not dug it, and that the horses, when not wanted for other purposes, are employed in assisting the diggers in preparing the land for seed. Twenty labourers are kept upon the farm instead of thirteen, who would be necessary under the ordinary system, and five or six horses instead of twelve. As the demands upon these horses, in hay and corn harvest, are considerable, a good proportion of the hay and corn is stacked in the fields where they are grown.

"It is hardly necessary, in support of these facts, to refer to the very considerable and successful extent to which the spade husbandry

prevails in many of the Continental states, such as in the north of Spain, France, and Flanders. Of the last the Rev. W. Rham observes—'The husbandry of the whole of the north-eastern part of East Flanders, where the soil is good sandy loam, may be considered as a mixed cultivation, partly by the plough and partly by the spade. Without the spade it would be impossible to give that finish to the land, after it is sown, which makes it appear so like a garden, and which is the chief cause of the more certain vegetation of the seed. There is also a great saving of seed by this practice, as may be seen by comparing the quantity actually sown in Flanders with that required in other countries where the spade is more sparingly used. In large farms in England, the spade is only used to dig out water furrows; but in Flanders, where the land is usually laid in stetches of about six or seven feet wide, the intervals are always dug out with the spade, and the earth spread evenly (*sifted* as they call it) over the seed which has been harrowed in. The trenches are so arranged that every year a fresh portion of the ground is dug out, and in six years the whole land will have been dug to the depth of, at least, one foot. In the next course, the trench is dug a few inches deeper, which brings up a little of the subsoil; and, after four or five such courses of trenching, the whole soil comes to be of a uniform quality to the depth of from eighteen to twenty inches, a most important circumstance to the growth of flax, potatoes, and carrots. In the Waes country they proceed differently, for they have a soil which, by repeated trenchings, has long been uniform in quality to the required depth; there they regularly trench one-sixth part of the land every year, and plant it with potatoes or sow carrots upon it.'

"If we direct our attention even to those cases where small plots of land are *exclusively* farmed, not gardened, by the spade or fork, the result is still more satisfactory; and here, too, the good effects produced, the strangely enlarged fertility of the soil, is almost entirely attributable to the deep forking. Let any traveller by the south-western railway (to take at once an extreme case) notice the results of deep stirring in some of the little cottage gardens enclosed from the heaths of Woking and Bagshot; let him witness the luxuriant little crops of both wheat and the common culinary vegetables growing in the gardens of these little peasants' nests, all looking as thriving and as luxuriant as possible; and yet this effect is all the work of the deeply penetrating fork or spade. Let the passenger compare these with the surrounding heath-covered lands, and it will be impossible for him to arrive but at one conclusion. The distant cultivator will judge at once of the natural poverty of the soil of Bagshot Heath by its chemical composition. It contains in 400 parts, after being heated to redness, 380 of coarse siliceous sand, 9 of fine siliceous sand, and 11 of clay, oxide of iron, and carbonate of lime. And it is not to the sandy soils that the benefits of fork husbandry are confined. On the chalky soils of Eastbourne, during the last few years, a considerable extent of land has been let out to about 400 little spade-cultivators, holding, as regards extent, in every proportion, from a few square rods to as many acres. One of these, George Cruttenden, a schoolmaster of Willingdon, reports, April 1842:—'The quantity of land I rent is five acres, on the side of the South Downs, at £3 per acre—this, with £10 for my house, makes £25. I have now three cows, a heifer, and a calf, standing opposite to each other, with a road between the mangers for feeding these stall-fed cattle. I am satisfied that I can keep two cows on the same quantity of land, stall-fed, that I could keep one if I allowed it to graze.' It is true that in this last successful instance, Cruttenden keeps a thriving little agricultural school, whose scholars, in return for their tuition, assist him in the cultivation of the five acres,—these yielded him a clear profit of £40 in 1842.

"It is an error into which the farmer very commonly falls, to conclude that there is any material difference in the earthy composition of uncultivated soils and the substratum; for, generally speaking, the only difference between the surface soil and the stratum on which it immediately rests consists in the upper soil containing a larger proportion of soluble and decomposing organic matter. It is only the absence of these from the substratum which renders it, when too copiously mixed with the surface soil, rather prejudicial at first than otherwise; and this is one reason why the fork is preferable in the first instance, of deepening the soil, to the spade or to very deep ploughing, since the fork deepens and loosens the soil, perhaps to a greater extent than either of the other implements, but then it does not bring to the surface so much of the substratum. There is no doubt with regard to the similarity of composition in the different soils and subsoils. The principal mineral in the soil of any district, as Mr. Morton observes, is that of the geological formation under it; hence we find argillaceous soil resting on the various clay formations, calcareous soil over the chalk and oolitic rocks, and siliceous soils over the various sandstones. On the chalk, the soil is white; on the red sandstone it is red, and on the sands and clays the surface has nearly the same shade of colour as the subsoil. And, in fact, we perceive a change in the external appearance of the surface wherever there is a change in the subsoil below. If, then, these are correctly stated facts—if such superior fertilizing effects are produced by the use of the fork beyond those which follow the plough—ought we not indeed to rejoice? Should we not exult that here is opened to the cultivator another source of fertility; one, too, not confined to any par-

ticular locality, not requiring the use of other agents than the sinewy arms of the agricultural labourers? Its general adoption, indeed, will afford a greatly extended supply of field work—labour, too, of the most healthy, the most valuable kind—carried on in the broad light of heaven, far away from the crowds, the diseases, and the other miseries which attend the densely congregated citizens."

SPANCEL. A rope to tie a cow's hind legs.

SPANIEL. See Dog.

SPARAXIS. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. About a dozen species, besides a number of varieties, have been introduced to the greenhouses of Britain; and they love a mixed soil of sand and peat and loam, and are propagated from offsets. They vary in height from 3 to 15 inches; and they present great diversity in the colour of their flowers. The name sparaxis is derived from a word signifying 'to tear,' and alludes to the lacerated spathes.

SPARGANIUM. See Bur-Reed.

SPARMANNIA. An ornamental, exotic, evergreen shrub, of the lime-tree family. It is a native of the Cape of Good Hope, and was introduced to the gardens of Britain in 1790. It commonly attains a height of about 10 or 12 feet, and blooms from March till July. Its foliage is large, cordate, and pendulous; its flowers grow in umbels, and are nodding; its petals are white, and have purple tips resembling anthers; and its general appearance is superb and brilliant. It may be treated similarly to the orange-tree, but requires a richer soil. It constitutes a genus of itself, and is specifically called the African.

SPARROW. A large family of birds of the passerinous order. It is characterized by a strong conical bill, more or less thick at the base, and non-angular in the commissure. It comprises a considerable number of genera, including the sparrows proper, the weavers, the finches, the goldfinches, the linnets, the widows, the grosbeaks, and others. Most of the species feed more or less on grain, and are voracious and more or less destructive on the farm. See the article Hedge-Birds.

The common sparrow or house-sparrow, *Passer domesticus*, *Fringilla domestica*, or *Pyrgita domestica*, is one of the best known and most mischievous of the small birds of Britain. Its general plumage is brown, spotted with black above, and with grey underneath; its throat is black; its wing is marked with a whitish band; and the sides of the culotte of the male are red. It infests farm-steads and other inhabited places in great numbers, and is distinguished by greed and audacity. It builds under the eaves of tiles, in crevices or holes of walls, in the bore of old water pipes, and in any other small cavities which contain space enough for the hay and feathers which form the nest. Its egg is ten lines long and seven lines broad, and has a white ground colour spotted and streaked with ash-colour and dusky brown. The first batch of eggs in a season commonly consists of five or six; and often two other batches are laid; and no fewer than fifteen young birds are often raised in a year by one pair. The young are fed for a time with soft fruits, young vegetables, and various kinds of larvæ and insects. The full-grown birds are general devastators of both the farm and the garden; and, though believed by some naturalists to do quite as much good by destroying weeds and insects as harm by destroying crops and fruits, they are justly regarded by most gardeners and by nearly all observing farmers as pests of the same class with the most noxious vermin. Good methods of destroying sparrows, therefore, rank as usefully in practice as good methods of destroying rats and mice.

One effectual mode of diminishing their numbers is to catch them in a net at night when they roost by whole companies in ricks and stacks, or in a large trap net with a decoy bird. Many may be killed at a single shot by scattering corn in a long train, and firing at them while feeding. Count Buffon having been told that if sulphur were smoked under trees where the sparrows sleep at night, they would be suffocated and drop dead, he tried the experiment, but without success, though he took much pains and was interested in the issue, as he could not get them driven from the neighbourhood of his voleries. He placed on a wall covered with great Indian chestnuts, where the sparrows assembled every evening in great numbers, pots filled with sulphur, mixed with a little charcoal and rosin; and these substances being set on fire, caused a thick smoke, which had no other effect than to awaken the birds. As the volume ascended, they removed to the tops of the trees, and then retired to the neighbouring houses, but not one dropped. Another experimenter, imagining that the sparrows might readily be poisoned, mixed some arsenic with oatmeal, and strewed it in the paths between the beds of seedlings, which they were daily devouring, but they never touched the poison, and his experiment was as unsuccessful as that of Buffon's with the sulphur. Another gentleman, who had a large kitchen garden much infested with sparrows and chaffinches, was induced to go to considerable trouble and expense to prevent their ravages. He caused his labourers, when not otherwise employed, to prepare rods of wood about two inches broad, an inch and a half thick, and ten or twelve feet long, joining them together at the ends with similar rods, nine feet long, and, in the centre of the same, a similar rod to strengthen it. This frame is then wired with copper wire, close enough to prevent the birds getting through. The frame thus prepared is raised over the beds upon pieces of wood six inches long,—one piece at each corner of the

frame, and one in the centre. Wire is likewise passed around these pieces of wood to prevent the birds getting in at the sides. He says it is much cheaper than netting, and more sightly than matting. These wire-frames must prove effectual; but few would like the expense and trouble who could avoid it. "I am convinced from my own experience," says a practical writer, "that threads, with feathers or bits of paper tied along, and suspended so as to dangle over the beds, will prove effective in scaring both sparrows and chaffinches, which, with all their pert impudence, are exceedingly wary and fearful of danger. A coat and hat stuffed with straw so as to have some resemblance to a man, will not intimidate them so effectually as the thread and feathers. A neighbour of mine once set up such a man of straw in a cherry tree to scare the sparrows from the ripe cherries, among which they were making sad havoc; but, after the first day or two, when the novelty wore off, they alighted close to it, and devoured the cherries as before. Netting, in such cases, is the only effectual preventive; and unless threads and feathers, which I have not tried, might do, netting, or tying up the bunches in gauze or thin muslin bags, is the only way of protecting ripe grapes on the open walls, of which sparrows are very fond, and devour great quantities, always selecting the largest and the ripest, and sadly disfiguring the bunches. Should any person choose to try the thread and feathers, it ought to be fixed at some little distance from the fruit on the wall, so as to allow the feathers to move freely, as it appears to be their motion which intimidates the sparrows. White worsted threads, without feathers or paper, will scare them from pease or spinage, for a short time in spring, though they soon become familiar with this; but I have never found that they venture near when feathers or paper are used." In the farm-yard, or by the side of corn-fields, or in other situations where sparrows alight in large numbers, and make great depredations upon corn or vegetables, they may readily be thinned by various easy methods of poisoning, such as steeping some wheat in a decoction of nux vomica, and scattering it on or near the spots which they frequent.

SPARROW-WORT,—botanically *Passerina*. A genus of curious and ornamental, exotic, evergreen shrubs and undershrubs, of the wild olive family. Between a dozen and twenty species, all white-flowered, and varying in height from 6 inches to 3 or 4 feet, and principally blooming in May and June, have been introduced to the greenhouses of Britain, chiefly from the Cape of Good Hope; and they are propagated from cuttings, and for the most part love a soil of sandy peat. The allusion to a sparrow in both the popular and the botanical names is founded on the beaked form of the seeds. See the article CRYPTADENIA.—The name sparrow-wort is also given to a curious, white-flowered, thymeæous annual from the south of Europe,—*Stellera passerina;* and to a curious, white-flowered, globose-flowered, evergreen, shrubby heath from the Cape of Good Hope,—*Erica passerina.*

SPARTINA. A genus of grasses, of the subterminally spiked tribe.—The strict species, *Spartina stricta*, grows wild in the salt marshes of the coast of Britain. Its root is perennial, creeping, and strongly fibrous; its stems grow several together, and are from 10 to 20 inches high; its leaves are numerous, smooth, striated, and of a dull green colour; and its flowers bloom in August. The whole plant is hard, rigid, and tough, and popularly bears the name of cord-grass, and possesses economical adaptations similar to broom,—and hence the botanical name spartina.—The rushy species, *Spartina juncea*, is a native of North America, and was introduced nearly 70 years ago to Britain. It is perennial, and has a height of about 20 inches, and blooms in July and August, and ripens its seeds about the middle of September. It has been proposed as a cultivated field plant for yielding fibre; and it would produce well on poor silicious soils which are unfit for flax or for corn. Its manufactured fibre is clear and as strong and soft as that of flax, but is deficient in length. The plant, too, is of small value for forage. In the Woburn experiments, it was grown on a rich silicious sandy soil, and it yielded at the time of flowering 33,350 lbs. of green produce per acre,—of which only 1,433 lbs. consisted of nutritive matter.—Eight or nine other species, all perennial-rooted, but more curious than useful, have been introduced from North America, France, and Java.

SPARTIUM. See BROOM.

SPASMODIC COLIC. See COLIC.

SPATALANTHUS. A small genus of ornamental exotic plants, of the iris family. The name signifies 'delicate flower,' and is descriptive. The showy species, *S. speciosus*, is a native of the Cape of Good Hope, and was introduced to Britain in 1825. Its root is bulbous; its stem is about six inches high; and its flowers are red and very brilliant, and bloom from June till August. It loves a soil of sandy loam, and is propagated from offsets.

SPATALLA. A genus of ornamental, purple-flowered, Cape-of-Good-Hope, small, evergreen shrubs, of the protea family. Ten or twelve species, varying in height from 20 to 40 inches, have been introduced to Britain; and most require to be propagated from seeds.

SPATHODEA. A genus of ornamental, tropical, evergreen, ligneous plants, of the trumpet-flower family. Eight or nine species, varying in height from 6 to 25 feet,—some climbers, some erect shrubs, and some small trees,—have been introduced to the gardens and botanical collections of Britain; and they love a loamy soil, and are propagated from cuttings. The long-flowered species, *S. longiflora*,—called by Linnæus *Bignonia chelonoides*,—is a native of India, and

was introduced to Britain in 1816, and possesses high consideration in its native country. The juice of its leaves is given in mixture with lime juice as a remedy in maniacal cases; the infusion of its pleasant-tasted root is used as a cooling drink in fevers; and its beautiful, fragrant, purple-coloured or reddish flowers are woven into garlands, and presented at the shrines of the Hindoo idols.

SPATHOGLOTTIS. A recently discovered genus of ornamental, exotic plants, of the orchis order. Fortune's species, *S. Fortuni*, was introduced a few years ago to Britain from the granite mountains of Hong-Kong; and is a dwarf, terrestrial-rooting plant, of considerable beauty. Its bulb or corm lies dormant for some months after the foliage has decayed; its leaves are plaited, lance-shaped, and two in number, and grow up from the root-crown; and its stem rises by the side of the leaves, and attains a height of about a foot, and bears four or five pale yellow flowers,—the sepals and petals of which are ovate, the lip divided, the side lobes blotched with crimson, and the middle lobe cuneate.

SPAVIN. A threefold disease in horses. See the articles Blood-Spavin, Bog-Spavin, and Bone-Spavin.

SPAYING. The destroying of the ovaries of heifers, bitches, young sows, and other female animals, in order to prevent conception and to promote fattening. It is usually done by making an incision into the mid-flank on the left side with a lancet or sharp knife, cutting off the ovary, and stitching up the wound. The part should be so dressed as to exclude the air; and the animal should be kept warm and quiet for two or three days after the operation. The spaying of heifers is practised far less now than formerly,—not on account of any failure of its object, but because the great improvement in the breeds of cattle has correspondingly enhanced the value of breeding cows.

SPEARMINT,—botanically *Mentha viridis*. An indigenous, culinary, and medicinal herb, of the mint genus and labiate order. It grows wild in marshy places. Its root is perennial and creeping; its stem is quadrangular, leafy, erect, smooth, branching, and about two feet high; its leaves are opposite, nearly sessile, lanceolate, pointed, serrated, smooth, deep green above, pale and sometimes a little hairy below, about 2½ inches long and 1 inch broad; and its flowers grow in long, pointed, panicled spikes, on smooth partial footstalks, and have a smooth, tender, funnel-shaped, purple-coloured corolla, and bloom in August. This plant has a strong aromatic odour, and a warm and slightly bitter taste; and it retains these properties after being dried, and yields them to both alcohol and water. It acts as a stomachic and a carminative; and is used both in culinary preparations and in medicine. Its herbage is cut green for making sauces; its herbage is cut just as the flowers appear, to be dried for medicinal purposes; and the whole plant is cut when in full flower, to yield the essential oil of spearmint,—and this oil has a flavour similar to that of peppermint, and is used medicinally for the same purposes, but is less pungent and less grateful. An infusion of the dried herb is serviceable in allaying sickness and vomiting occasioned by weakness of the stomach. The plant is propagated in kitchen gardens by parting the roots in spring and autumn, by removing and transplanting young offset plants in March and April, and by cutting off the stalks in summer.

SPEARWORT. See Crowfoot.

SPECIES. There are several considerations which clearly establish the important fact that species have a real existence in Nature; that certain forms have been assigned to each animal from the origin of things; and that although the animals are liable to diverge from their primitive forms, they always possess a preservative tendency, a *nisus formativus*, and are ever ready to revert to the original type when the external causes of change are removed. The entire animal kingdom is divided into a number of distinct species, each of which perpetuates its own form, without ever transgressing certain limits, or acquiring the characters of another species.

In all the varieties observed to arise among the mammalia, the form of the bones preserves a remarkable stability, which would not always be expected from the appearance of the external parts. The Baron Cuvier compared the skulls of foxes from the North of Europe and from Egypt with those of France and with each other, yet he found no other differences than such as might distinguish one individual from another. The antlers of the rein-deer and stags often vary in size, and the same may happen with the tusks of the elephant; but two individuals of any one of these species, however dissimilar they may be in size, do not exhibit the slightest difference in the number of their teeth, or the articulations of their smallest bones. This is also observed with the domestic cattle, which may be destitute of horns, or have them of variable length, and yet they possess an exact correspondence in all the other parts of the skeleton. Thus the forms of the bones in general vary but little; while their modes of connexion, their articulations, and the form of the great molar teeth, remain constantly the same in each species. The divided hoof of the hog sometimes becomes consolidated, and this may be regarded as the extreme limit of variation among the bones of our domestic herbivorous animals. The variations of the bones in the different kinds of dog have undergone a special examination by M. Frederic Cuvier, performed at the request of his brother upon the specimens at the 'Museum d'Histoire Naturelle.' To enter fully into the details of this investigation would at present be out of place. It will suffice here to mention, that a general corre-

spondence in all the parts of their skeletons was found to exist, and at the same time some important variations, especially in the degree of elevation of the frontal sinuses. The teeth were always of the same number and general form; sometimes an additional false molar, or a tubercle, was observed on one side or on the other. It is well known that all dogs have five toes on the fore-feet, and only four on the hinder, while there is a slight trace of a rudimental fifth toe in the hinder metatarsal bone, which, however, shows no appearance on the outside. These toes being of unequal length, usually preserve the same relations in all the races; but sometimes a fifth toe exhibits itself on the internal surface of the hinder-feet. It is, however, generally very short and imperfect, and this last is the maximum of variation found in the skeletons of all the races of dogs. It thus appears abundantly evident, that animals now possess certain characters which remain permanent, and resist all modifications, whether arising from climate or domestication, or from a natural tendency to run into connate varieties.

Time, however, it has been said, may effect a perceptible modification in the entire characters of species. Fossil remains, and other geological monuments, appear to show that millions of years have elapsed since the first species of animals inhabited the earth, and it is asked, may they not have undergone many modifications during the interval? It is evident that we can only ascertain the effect which a very long time will produce, by comparing it with the change actually observed to have taken place during a shorter period. MM. Cuvier and Geoffroy-Saint-Hilaire sought out the most ancient documents which Egypt could afford, for the purpose of solving this question, so important to the naturalist, and essential to a knowledge of the past history of our globe. M. Cuvier examined with great care the ancient Egyptian obelisks transported to Rome, and found a perfect resemblance between the general form of the animals engraved thereon, and the common species of our own day. M. Geoffroy collected as many mummies of the lower animals and of man as he could find, and was led to form a similar conclusion. These monuments must have been from 2,000 to 3,000 years old. "For a long time," says M. Lacépède in the report he made upon these objects in common with MM. Cuvier and Lamarck,—"for a long time philosophers have been anxious to know whether species change their forms during the course of ages. This question, apparently trivial, is yet essential to the history of the globe, and to the solution of a thousand other questions not far removed from the gravest objects of human veneration. Never were we in a better condition to decide the question upon a great number of remarkable species, and for a long period of years. The superstition of the ancient Egyptians would almost seem to have been inspired by Nature, for the purpose of bequeathing to us a monument of her history. A people of fantastical opinions, by embalming with so much care the brute beings, objects of their stupid adoration, have left in their sacred grottoes complete cabinets of zoology. The climate has united with the art of embalming to preserve these bodies from all corruption, and we have now the means of ascertaining with our own eyes what was the condition of these animals 3,000 years ago. One can scarcely restrain the raptures of imagination upon seeing at the present day an animal preserved, with the smallest bone and hair perfectly distinguishable, which had 3,000 years since in Thebes or Memphis its priests and altars. But without wandering into all the subjects to which these associations give rise, we shall confine ourselves to noticing the simple fact—that these animals perfectly resemble those of the present day."

Although the bones of a species do not vary to any extent, yet the identity of osteological characters is not alone sufficient to establish an identity of species; and some species which possess a most exact similarity of structure are held, by the general consent of naturalists, to be of different species. It is almost impossible to distinguish the skeleton of the wolf from that of the wild dog of New Holland. Their teeth are the same; the vertebræ of the tail are equal in number; the feet have the same number of toes; and the bones of the head exhibit the same relations, except that the orbital fossæ are slightly larger in the wolf. The same thing occurs in the wolf of Canada, which is smaller than the common wolf, and larger than the dog of New Holland. The jackal also resembles the wolf-dog very closely, especially in the form of the head. There is likewise a most exact similarity in respect to the organs of sense among the New Holland dog, the Canadian wolf, and the jackal. Again, the quality and arrangement of the hair exhibit no essential differences, for they all may have either woolly or silky hair, according as they have been naturalized in cold or temperate countries. In fact, they only differ in colour. Yet all these genera merely vary from white to brown or black, and excepting the black wolf, which has the hair of a uniform colour, the others have hairs of fawn, black, or white so mingled together, that it is difficult to set down any colour as peculiar to either species, and which will not pass by insensible shades into another. What then, it may naturally be inquired, forms the distinction between a species and a mere variety; and how are we to ascertain those permanent characters which were assigned to our domestic animals at the origin of things? If these questions be considered in a purely abstract form, no difficulty can arise, as we have only to include in the same species all those animals, whose differences of external form and garb can be traced to some acknowledged causes of variation; while

the animals whose differences cannot be thus explained, must be held to belong to separate species. "Where two races of animals are distinguished by any undeviating marks in such a way that they never will, under any circumstances, pass into each other, or that the progeny of either can never acquire the characters of the other, they are of distinct species, and it matters not how wide or how narrow be the line of discrimination, provided that it never be broken in upon." But when we come to apply these abstract rules to the realities of Nature, we find that they are not always sufficient to distinguish the mere variety from the genuine species. The difficulty is further increased by the circumstance that many varieties or races of some species differ more decidedly among themselves, than the species of certain genera, where the objects are very numerous. Again, the greater part of our acquisitions are imported from remote and barbarous countries. "A large proportion," as Mr. Lyell observes, "have never even been seen alive by scientific enquirers. Instead of having specimens of the young, the adult, and the aged individuals of each sex, and possessing means of investigating the anatomical structure, the peculiar habits and instincts of each, what is usually the state of our information? A single specimen, perhaps, of a dried plant, or a stuffed bird or quadruped; a shell without the soft parts of the animal; an insect in one stage of its numerous transformations;—these are the scanty and imperfect data which the naturalist possesses. Such information may enable us to separate species which stand at a considerable distance from each other; but we have no right to expect any thing but difficulty and ambiguity, if we attempt from such imperfect opportunities to obtain distinctive marks for defining the characters of species which are closely related. When our data are so defective, the most acute naturalist must expect to be sometimes at fault, and, like a novice, to overlook essential points of difference, or pass unconsciously from one species to another."

Buffon established the criterion for the determination of species in the power of producing, by their union, races equally fertile with themselves, and this rule seemed to be confirmed by the experiments of John Hunter. They were of opinion, "that if a male and female produce an offspring which is prolific, the tribes to which the parents respectively belong are hence proved not to be specifically different, and whatever diversities may happen to characterize them, are in this case to be looked upon as examples of variation. But if the third animal be unprolific, it is to be concluded that the races from which it is descended are originally separate, or of distinct kinds. The fact that most hybrid animals are wholly unprolific, would appear to be a provision for the attainment of this desirable end, and for maintaining the order and variety of Nature. For if such had not been the condition of these intermediate animals, we have reason to believe that all the primitive distinctions would have been long ago totally effaced; a universal confusion of species must have ensued, and there would not be at this day one pure and unmixed species left in existence. The naturalists above mentioned, inferring, from the apparent utility of this law, that it must universally prevail, obtain by means of it a ready method of determining on identity and diversity of species." It is very clear that if two animals are prevented by any great disparity of organization or disposition from uniting, that the criterion of generation holds good to a certain extent. The bull and the goat, for example, would at once be pronounced to be distinct species. This rule may enable us to assert that two animals are not of the same species, but it does not always serve to discriminate between nearly-allied species. Hence it seems rather to be the first rude attempt at forming a criterion, than one which serves to mark out nice distinctions. The crosses among the dog, the wolf, and the jackal;—between the goat and the sheep;—the horse and the ass;—the lion and the tiger, with the occasional appearance of fertile hybrids in many, and the possibility of its occurrence in them all, show that the converse often fails. Although animals which do not generate together belong to distinct species, yet it is not true that distinct species must not generate together, nor does it follow that their progeny must always be sterile.

The determination of species by the property of producing fertile races, had previously been restricted by Frisch to such as generate together of their own accord, "von Natir mit einander gatten." Those artificial unions brought about by restraint, artifice, or domestication, were wholly excluded by him. But this restriction renders the rule useless in practice for determining those points where difficulties may chiefly be expected to arise. It is in respect to man and the domestic animals, or with animals brought from distant and uncivilized countries, that a rule is most required to distinguish the species from the mere variety. Blumenbach inquires, "When will it come to pass that all nearly-allied animals shall be brought together from remote countries, so as to submit them to the requisite experiments,—for example, whether the chimpansé, *Troglodytes niger*, from the Angola coast, will form a fertile race with the Orang outang, *Pithecus satyrus*, from Borneo?" This is a desideratum which the general establishment of zoological gardens alone can supply, but in the meantime we must seek some other criterion, which shall be applicable to man and the domesticated animals, for the determination of species. It is here that difficulties arise in drawing the line between the species and the variety. Tiliesius considers that several distinct species are confounded under the name of jackal or chacal, *Canis aureus*, while both Pallas and Gulden-

staedt regarded the jackal of Caucasus as the original source whence our domestic dogs are descended. Others again thought that the different kinds of dog have diverged fron the shepherd's dog, while some considered them all but as degenerations from the hyena, the wolf, or the fox. Thus it is precisely in those places where a fixed rule is most required that the breeding principle wholly fails, and we may seek in vain for any other. Blumenbach could propose none, but referred the determination of species to analogy and probability. "Fere desperem," he observes, "posse aliunde quam ex Analogia et verisimilitudine notionem speciei in Zoologiæ studio depromi." (I may almost despair of being able to derive the idea of species in the study of Zoology from any other source than analogy and probability.) Two races of animals which possess a general resemblance, and differ only in those respects which have been observed to vary, and can be traced to some well-known causes of variation, must at once be admitted to belong to the same species; but however near their general appearance may be, if they exhibit any difference which, in all our experience of the animal kingdom, has never been known to exist as a variety, they must be set down as distinct species. The proper determination of species rests, therefore, upon the knowledge of an immense number of facts, and forms one of the most difficult, as it is one of the most important, subjects to which the naturalist can direct his attention. Thus Blumenbach considers the ferret to be merely a variety of the polecat, *Mustela putorius*, not because they generate together, for perhaps the experiment may not yet have been made, but because the former is white with red eyes; and, from that well-known rule of analogy, that the same effects must be referred to the same causes, its origin is the same with those albino varieties produced daily among the domesticated mammalia. Again, the Indian elephant, *Elephas Indicus*, differs remarkably from that of Africa, *E. Africanus*, in the number and form of its molar teeth. Whether these animals will engender together it is perhaps difficult to determine; but on examining every specimen which reaches this country, the same difference is found to exist. Further, we know of no analogous instance of variety in the formation of the molar teeth among wild or domesticated animals. We, therefore, do not hesitate to set down these two elephants as distinct species.

There are other difficulties arising from the want of accurate information; and these, in the present state of the science, occur but too frequently. For example, the skin of an animal arrives from the Cape of Good Hope. At the first glance it appears, perhaps, to be a specimen of the common Cape otter, *Lutra capensis*, and this opinion may be further confirmed on examining the structure of its teeth. The colour of the breast and throat may seem of a purer white, and to be more extensive than usual, but this is a characteristic which might belong to a mere variety. On looking at the feet, we are much surprised at finding all the toes without nails, excepting on the second and third of the hinder-feet, where only a rude vestige of a nail can be observed. A carnassier without claws would seem an anomaly in creation. To suppose a being, compelled by its structure to live on animal food, and yet to be refused by Nature the weapons fitted for seizing its prey, disturbs our ideas of final causes, and we delight to trace order and regularity in the works of creation. The specimen must then be imperfect. It belongs to an old individual;—perhaps the claws may have dropped off through age or disease. We set it down, therefore, as a mere variety of the *Lutra capensis*. Some years afterwards, young individuals are brought with the nails entire; the first view then seems abundantly confirmed; perhaps even we applaud our own sagacity, and our extensive knowledge of final causes,—of those ends and uses for which the Creator designed the various parts of the animal world. Finally, another young individual is imported with all the characters of the original specimen, thus proving it not only to have been a distinct species, but entitling it to the rank of a separate genus—the *Aonyx*, or Nail-less otter of M. Lesson; and one more instance is afforded of the inexhaustible variety in the works of nature. When we find that even the possession of claws is not always indispensable to the subsistence of the carnassier, we may thence derive the salutary caution, not to confide too implicitly in analogical reasoning, if we wish to form correct views regarding new or unknown natural objects.

Since the supporters of the permanent characters of species thus find it difficult to fix any very definite rule for determining them, and as the characters themselves are seen to run into innumerable varieties, two very different theories have been proposed. Linnæus and Buffon asserted that only a small number of stocks were originally created, from which all the existing species have degenerated and diverged, from the influence of climate, food, and domestication, aided by a promiscuous intercourse, which has been limited only by their progeny ceasing to produce fertile races. On the other hand, Lamarck considered that the form of the body, and all the characters of species, were the consequence of the habits, the manner of living, and other circumstances, which have, in the course of time, given rise to the form of each species. Further, that man, and each higher animal, has originally risen from some lower division of the animal kingdom, by the gradual transition of the characters of one species into another, but always from the lower to the higher, with the transmission of such commuted characters to their posterity. These theories both agree in denying the fixed character of species. That of Linnæus

and Buffon would remove the character of durability from the species to fix it in some original stock, the type of the genus, the family, the tribe, or perhaps even of the order. That of Lamarck would overturn the permanent character of all forms. The first asserts the degeneration, the second the gradual development and perfectibility, of species. While the one reposes chiefly on the phenomena of variation, the other rests upon those general analogies among species, which have led Bonnet to form his universal chain of existence, and later writers their circular theories.

It is to Linnæus that we must assign the merit of relieving systematic botany from those accidental varieties which spring up daily in our gardens, and had been improperly raised by Tournefort and other former botanists to the rank of species. But the zeal of this great Naturalist in bringing down varieties from their undue elevation, led him to conjecture that many of those plants which had been discovered since the time of Tournefort might have been produced, during the intervening period, by the intermixture of species. From the impregnation of one kind of plant with the pollen of another, he was induced, not only to suspect that nature now produced new species by this means, but that, even at the origin of things, there had been created only a certain number of simple genera, the continual crossing of which has given rise to the immense number of species at present known. This hypothesis, which originated from the consideration of plants, was afterwards extended by Linnæus even to animals, and however plausible it may at first sight appear from contemplating those races, by which Nature has so infinitely varied some species in different parts of the globe, it seems, on a further consideration, to be wholly untenable. Contrivance and ingenuity, on the part of man, are always seen to be necessary to bring about the production of a hybrid or cross between two different species. There is further an impossibility of perpetuating these crosses as species or distinct races, arising either from their absolute or relative want of fecundity, or from that degeneration and deterioration to which their issue is subject. They always require the assistance of one of their primitive stocks, to prevent the new race from becoming wholly extinct. Further, in those genera and classes where the objects are very numerous, we often see two or more species formed evidently upon the same model, which may be more or less varied, yet they always remain distinct from each other. Examples of this are not wanting from the quadrumana and cheiroptera to the lowest species of zoophytes. We also see that those peculiarities which serve to characterize the several species, genera, or even natural families, continue to exist without there ever appearing before our eyes new links between allied species. For nearly two centuries, animals and plants have been observed with great care, yet there has not been one authenticated instance of a distinct and constant species, which has yet been proved to be of modern origin. Finally, those fossil shells and bones found in earthy strata, deposited during the earlier ages of animal life, exhibit the same variety, not only of those forms which are found at the present day, but also of many others now wholly extinct. These facts are opposed by a mere probability or conjecture, and we are hence compelled to consider species, although very nearly resembling each other, to have been so formed at the origin of things.

Buffon has carried these views regarding the degeneration of species among animals to a much greater extent than Linnæus did in respect to plants. After reducing the numerous races of domestic animals to certain original stocks, he grouped the allied species of quadrupeds into races or natural families. Assuming certain species to be the primitive stocks from which the numerous allied species at present existing have descended, he thence attempted to explain their degeneration, partly by their close affinities, but chiefly by those causes which are sufficient to vary the domestic animals. He thought that species, such as now are commonly admitted, did not formerly exist, and that we must seek for their characters in those natural groups which have served to form genera or families. The degeneration of species, according to Buffon, was one which preceded all history, and formed the most ancient of their changes. It appeared to arise in each family, or in each of those genera under which nearly-allied species are usually comprised. Only a few isolated kinds, he remarked, formed, like man, at once the species and the genus. The elephant, rhinoceros, hippopotamus, and camelopard, according to him, composed simple genera and species which were continued in a direct line, and without any collateral branches; while all the others appeared to form families, in which a chief and common stock might generally be observed, from which there seemed to proceed different offsets, increasing in number according as the individuals in each species were smaller and more fertile. Buffon on these principles reduced all the species of quadrupeds then known to thirty-eight families. He admits that this state of Nature has not come down to us, but is, on the contrary, the remnant of a former state of things, and that we can only acquire a knowledge of it "by inductions and relations nearly as fugitive as the time, which seems to have obliterated all traces of its existence."

Notwithstanding the opinion which M. F. Cuvier has hazarded upon this theory, "that it even now presents an appearance of the greatest probability," it is one to which we can by no means subscribe. After making due allowance for the influence of climate, food, and the numerous accidents to which all the individuals are

subject, these causes are wholly insufficient, however long we may suppose them to operate, to change the entire forms of animals, their proportions, and even their internal structure, to such a degree as this hypothesis would require. We see that those domestic animals which man has transported to the most opposite climates, have only changed the quality of their hair or their colour. The influence of pasture can only alter the height, the proportion of the horns, or perhaps add some lumps of fat to the body. But a small number of generations spent on another soil are sufficient to overturn whatever this race may have acquired during ages of cultivation. Again, if we consider those species, whether mammalia or birds, which are most populous in individuals, and at the same time the most fertile, the entire of their observed variations are by no means great. Some species which are very populous are nearly exempt from varieties, while others, though less fertile, vary much. Thus the common mouse and the mulot, *Mus sylvaticus*, are perhaps as populous as any species; yet their variations are rare;—and an infinite number of instances might be brought forward among the fishes and insects. There are even species very nearly allied to each other, and almost equally distributed in opposite climates, of which the one has run into a great number of varieties, while the others every where preserve a uniform resemblance to each other. The Polish marmot, *Arctomys bobac*, and the Siberian marmot, *Spermophilus citillus*, are striking instances that a vegetable diet does not give rise to greater varieties than animal food. The Polish marmot lives only on vegetables without ever touching animal substances, yet it remains unvaried, according to Pallas, from Poland to the banks of the Lena. On the contrary, the Siberian marmot, which is as carnivorous as the surmulot, *Mus decumanus*, has undergone many important variations of size, colour, and proportion in the same latitudes, and under similar circumstances.

Although the influence of DOMESTICATION [see that article] has a much more powerful tendency to occasion variation, than all those reverses and changes which the wild species can experience, yet man has not succeeded in altering the nature of any one of these animals, so as to form a new, distinct, and permanent species. The horse and the ass, in their transitions from the wild to the domesticated state, have undergone less variation than some other wild species, which climate alone has been sufficient to modify. The Bactrian camel and the dromedary retain their natural forms in the few countries where they are naturalized. Buffon considered the humps of the camel to have been occasioned by the long habit of carrying burdens; but the wild camels of Thibet and China have the same humps and callosities as their domesticated brethren. Pallas has correctly observed, that he might as well have regarded the follicule of the musk, and the dorsal gland of the peccari, as abscesses arising from disease. The ass is more harshly treated than the camel, the alpacas are as much accustomed to carry burdens, yet they are without humps. The horse and the ass have not acquired callosities on those places where they have so long been exposed to the friction of the saddle and harness.

Climate and food, however long we may suppose these causes to operate, are wholly unable to account for the existence of the numerous species of animals which cover the face of the globe. We see that the preservation of the races among our domestic animals, and the improvement of the breeds, depend chiefly upon the peculiarities of the individuals selected to propagate. Graziers have long since laid down those rules by which the domestic animals, and especially the horse, can be rendered larger, more beautiful, or more vigorous than they would have been if left uncultivated. But it is only by continued care that the purity of the breeds can be preserved, and they ever exhibit an inclination to resume the characters of the wild animals. We thus see that the tendency of the offspring to retain the characteristics of its parent is powerful enough to counteract all those causes which may modify the external forms of animals. Thus the introduction of rams of a good breed corrects the fleeces of the worst flocks in a single generation, and even in the least favourable climates. The Angora goat has imparted his silky fleece to the Swedish flocks, and they maintain this character for several generations. In Russia also, the stallions with a frizzled and crisp hair, impart to their foals a similar coat and of the same colour. The wild, as well as domestic animals, also tend continually to maintain their primitive forms in opposition to all the influences of climate and food, which are wholly insufficient to induce this supposed degeneration and degradation of species. Whenever some accidental connate deformity or partial excrescence becomes hereditary, as sometimes happens, the natural liberty of intercourse soon re-establishes the original form; and it is only by interfering with their unions that we can succeed in rendering permanent the accidental varieties of our domestic animals. In the wild state also, the females are led instinctively to prefer the most courageous of the males, the most perfect, and the most masculine of their species. The males, likewise, instinctively prefer the most beautiful of the females; and thus they both tend to transmit to their offspring the most perfect form of their species. See the article BREEDING.

Since Nature then has placed an instinctive mutual aversion in animals of different species, —since she has rendered hybrids either sterile or weak and imperfect,—if allied animals distributed in remote parts of the globe are found to be incapable of yielding fertile races, we have presumptive evidence that this supposed degen-

eration of species cannot have existed, and we derive from the known insufficiency of the present causes of change a positive ground for inferring their descent from distinct original types. The mere circumstance of our being able to induce by art and contrivance a fertile union between two species, is not sufficient to counteract this evidence, when we see that these same species preserve themselves distinct in the wild state, and continually maintain certain well-defined peculiarities. Pallas was led to infer that some of our domestic animals, such as the sheep, the goat, and the dog, are factitious beings, not proceeding from any permanent origin, but from the union of several distinct species, such as the dog from the wolf, the fox, and jackal; the sheep from the mouflon and Siberian argali; and the common goat from the Persian and Caucasian goats with the ibex. We know that these animals have given rise to fertile hybrids; and hence it becomes impossible to say how far their varieties may be owing to foreign contamination, or to the occurrence of connate varieties in the original species. It is, however, useless to indulge in conjecture where data are defective; but from analogy we might infer that a very small part of their varieties have been owing to foreign admixture.

It now remains for us to notice the theory of the successive transition of species proposed by M. Lamarck. According to him, the habits and manners of life assigned to each animal do not follow from any original form peculiar to its species; but that, on the contrary, the form of each species is the result of its habits, its manner of life, and other influential causes, which, in the course of time, have constituted the shape of the body and the parts of the animal. With new forms, new faculties have been acquired; and thus gradually Nature has produced the animals as we now see them. We must in justice remark, that this theory has been censured in this country with undue severity, from its appearing at first sight to dispense with the agency of a First Cause in the creation of the several species of animals. But in reality, a creative power is as indispensable in *maintaining* the successive transition of forms, as in originally *creating* them. Lamarck himself was well aware of this, for he observes, "When I see that Nature has placed the source of all the actions of animals, of all their faculties, from the most simple to those which constitute instinct, industry, and finally reasoning—in their *wants*, which alone establish and direct their *habits;* ought I not to acknowledge in this power of Nature, that is to say, in the existing order of things, the execution of the will of its Sublime Author, who has imparted them the power?" As an illustration of this supposed transition of species, we shall show M. Lamarck's method of explaining upon his theory, how it comes to pass that some mammalia can fly. A very ancient race of common squirrels had long amused themselves with leaping from tree to tree, and thence had acquired a habit of extending their limbs like a parachute. From frequent repetitions of this act, the skin of their sides became gradually enlarged, in course of time, and a loose membrane extending from the fore to the hind feet, embraced a large volume of air, and broke the force of their fall. In a word, they acquired the characters of the flying squirrels, —*Pteromys*. These animals, however, were still without membranes between their fingers. But a race of squirrels of much higher antiquity, after undergoing the preceding metamorphosis, had acquired a habit of taking still longer leaps than the former. Accordingly the skin of their sides became more ample, uniting not only the fore and hind legs, but even the tail with the hinder feet, as well as the fingers with each other. These now form our flying lemurs,—*Galeopithecus*. There was, however, a third race of squirrels vastly more ancient than any of these, which had contracted a habit, in the course of time, of extending not only their limbs, but also their fingers. From this habit, long preserved and become inveterate, they not only acquired lateral members, but an extraordinary elongation of the fingers of the anterior limbs, with large intermediate membranes, so that at length they constituted those singular wings which we find in the bats,—*Vespertilio*. "So great is the power of habit," observes Mr. Lamarck, "that it singularly affects even the conformation of the corporeal parts, that it imparts to those animals which have contracted certain habits through a long course of ages, certain faculties which other animals of different habits do not enjoy."

Upon this theory, it was requisite that the higher orders of animals should be regarded as of the greatest antiquity, a longer time being necessary for their transition from those simple forms, which were supposed to have been first created. "I have no doubt," proceeds Lamarck, "that all the mammalia have originally sprung from the ocean, and that the latter is the true cradle of the whole animal kingdom. In fact, we still see that the least perfect animals are not only the most numerous, but that they either live solely in the water, or in those very moist places, where Nature has performed, and continues to perform, under favourable circumstances, her direct or spontaneous generations; and there, in the first place, she gives rise to the most simple animalcules, from which have proceeded all the animal creation."—(Philosophie Zoologique, tom. 2, p. 456). We must remark, that there has never yet been, within the historical era, a well authenticated fact of any animal of one species having acquired organs or faculties belonging to another; nor are any species known to have lost any of their senses or powers to make way for new ones. It must further be observed that, while we have never found any of these transitions in circumstances within the sphere of our

investigations, Lamarck places them precisely in those, where they cannot be proved or disproved by direct observation. Where did these transitions begin? In the abysses of the ocean, where man has never penetrated, and where myriads of beings lie concealed from his observation, perhaps for ever. What animals owe their origin to spontaneous generation? Animalcules, a class of beings the most remote from our observation, and whose forms can only be traced through the deceptive medium of the microscope. When did these transitions occur? Before the historical era, in those remote and inaccessible ages, whose existence is alone attested by the organic remains imbedded within the surface of the earth. But, observes Lamarck, "there is a very good reason why we do not see those changes successively performed, which have diversified the known animals, and brought them to their present state. We see them only when they are finished, and not when undergoing the change; and we very naturally infer that they always have remained as we see them." This is a prejudice. "If the average duration in the life of each generation of men were only a second, and if there be a pendulum mounted and in motion, each generation would consider this pendulum really to be at rest, never having seen it change in the course of their lives. The observations of thirty generations would not demonstrate any thing positive concerning the vibrations of this instrument."

We may remark, that our sole means of judging of unknown objects is by comparing them with others which are known, and that it is unphilosophical to found a theory of what occurs, or has occurred, in remote and inaccessible parts of the creation, in direct opposition to what is seen to happen within our own sphere of observation. The earth appears to be at rest, if it be compared with objects on its surface; and we reason correctly, for, *in respect to them*, it is at rest. But on referring it to the solar system, we at once perceive it to be in motion. Again, if we compare the entire solar system with the more remote heavenly bodies, analogy would lead us to expect that our system may be in motion towards the fixed stars, and that these stars themselves may only be fixed, relative to our own limited means of observation. To suppose the fixed stars to be really motionless, would be as great a violation of analogical reasoning, as those theories inflict which deny the permanent characters of species. All the sciences adopt this mode of reasoning when the contemplated object is inaccessible to direct experiment or observation. On looking abroad into Nature, the chemist finds every thing in a state of composition. He nowhere discovers pure oxygen, chlorine, calcium, or potassium, because nearly all the unions which simple substances were capable of forming spontaneously have already occurred. The naturalist is disposed to imagine that something similar to this may have taken place among the species of animals and plants; but the chemist analyzes the compounds of these substances himself, and he sees their combinations going on before his eyes. The naturalist cannot bring forward one single instance of the degeneration or transition of species from one form to another. The weak point of the Lamarckian doctrine, in the absence of positive proof, is a violation of one of the first rules of analogy. Mr. Lyell correctly remarks, in his recent criticism on this subject, that "no positive fact is cited to exemplify the substitution of some *entirely new* sense, faculty, or organ, in the room of some other rendered useless. All the instances adduced go only to prove, that the dimensions and strength of members, and the perfection of certain attributes, may, in a long course of generations, be lessened and enfeebled by disuse; or, on the contrary, be matured and augmented by active exertion, just as we know that the power of scent is feeble in the greyhound, while its swiftness of pace and its acuteness of sight are remarkable;—that the harrier and staghound, on the contrary, are comparatively slow in their movements, but excel in the sense of smelling. It is evident, that if some well authenticated facts could have been adduced to establish one complete step in the progress of transformation, such as the appearance in individuals descended from a common stock, of a sense or organ entirely new, and a complete disappearance of some other enjoyed by their progenitors, that time alone might then be supposed sufficient to bring about any amount of metamorphosis. The gratuitous assumption, therefore, of a point so vital to the theory of transmutation, was unpardonable on the part of its advocate."

We have now seen that some mammalia are capable of undergoing a very considerable variation, not only in their instincts and intelligence, but also in their external forms; that the variations which each individual can be made to undergo by the circumstances in which it is placed are but very rarely transmitted to posterity, while connate modifications usually end in becoming hereditary;—and that there are certain limits beyond which no species has been observed to vary, so that we are fully entitled to conclude, that a certain form was assigned to each species at the origin of things.

If it be true that the numerous varieties of the cow, the horse, the dog, and other domestic mammalia, are the effects of the slow and continued influence of certain causes, which in the first instance, induce a departure from the primitive type in the evolution of connate varieties, and afterwards transmit these variations to posterity, giving rise to their several distinct races; —it ought to follow, that in all these artificial beings, whose characters man has for a time rendered permanent, there should be a continual tendency, when left to their own resources, to

assume the form of the original type. On allowing the domestic animals to run wild,—on permitting them to substitute the wandering habits and precarious subsistence of mountains and forests for the uniform and regular diet of the stable, we ought to find that their acquired characters disappear, that all the individuals bear that marked resemblance to each other, which will serve to indicate both the identity of their species, and the original form from which the races have diverged. The experiments confirming the truth of this conclusion have long been performed on the largest scale in the immense continent of America. It is well known that the Europeans, on the first discovery of the New World, sought in vain for any vestige of that animal creation to which they had so long been familiarized. Those useful animals, without whose aid, in the first instance, the civilization of man might have been indefinitely retarded, had to be transported to America to supply the immediate necessities of the earlier colonists. Soon, however, the accidental flight of some animals to the woods, hastened probably by the abundant supply of food, and a favourable climate, which, in increasing their fecundity, rendered a vigilant care of them superfluous, a large proportion became absolutely wild, and the establishment of wild individuals in the immediate neighbourhood of the tame herds, soon exerted a direct modifying influence over the latter. Hence, in America, we may see performed, on a magnificent scale, the converse of that gradual modification which the domestic animals underwent in their original transition from the wild state; and may further compare those half domesticated herds, acknowledging only a partial submission to man, with the humble individuals of their own species, which still yield him a patient and implicit obedience.

It is evident that careful observations should be multiplied over the whole continent of America, in order to render this investigation complete; but we owe to M. Roulin the merit of having traced some changes in a portion of this vast country. That learned physician, during his residence in Colombia for six years, has collected a number of interesting facts which were communicated to the Royal Academy of Science at Paris in the year 1828. These observations were made in New Grenada and a part of Venezuela, from the 3d to the 10th degree of north latitude, and from the 70th to the 80th degree of west longitude. However limited this tract of country may appear, it offered unusual facilities for observation, being traversed throughout its entire course by the great cordilleras of the Andes, which are here divided into three principal chains; so that, within the distance of a few leagues, the same living animals were investigated, though resident in one district, where the medium temperature is only 50° Fahrenheit, and in another where it varies from 77° to 86°. The mammalia transported from Europe to America were the hog, the horse, the ass, the sheep, the goat, the cow, the dog, and the cat. It becomes important to ascertain whether these animals retain the forms acquired in Europe, or whether they have undergone any considerable change. By carefully comparing these phenomena with the circumstances under which they have arisen, much light may be thrown upon those modifications which probably attended the transition of these animals from the wild to the domestic state.

The first hogs brought to America were introduced by Columbus, and became established at Saint Domingo in November 1493, being the year which followed its discovery. During the following years they were successively carried into all those places where the Spaniards attempted to fix themselves, and, in the period of about half a century, they might be found wild from the 25th degree of north to the 40th of south latitude. In no place do their important changes appear to have been effected by climate, and they have reproduced everywhere with the same facility as in Europe. Most of the pork consumed in New Grenada comes from the warmest valleys, where the hogs are bred in large numbers, from their maintenance costing but little. During some seasons they are even supported wholly by wild fruits, and especially by those of the several species of palms. From roaming constantly in the woods, the hog has lost in this district all traces of his former domestication. His ears are straight and erect, his head has widened and become elevated in the upper region. The colour has again become constant, being entirely black. The young pigs have several fawn-coloured stripes, like the European wild boar in its youth, and upon a ground of the same colour. Such are the hogs brought to Bogota from the valleys of Tocayma, Cunday, and Melgar. Their hair is scanty, and on this account they bear a striking resemblance to the wild boar of Europe, from a year to eighteen months old. This deficiency of hair is not, however, peculiar to the hogs of Grenada, but is also experienced by the common wild boar of Europe. M. Roulin observed an instance of it in France, at a farm near Fougères, where seven or eight of these animals were brought up together. One of them, being about two years old, had been fed in a stable from the beginning of spring, with the intention of fattening it for the market. Though the animal had not been closely confined in this place, the good feeding of the stable was sufficient to induce it to remain at home. Its hair had almost wholly fallen off from the effects of the heat, and it exhibited a most perfect resemblance to the hogs of Melgar above described, except that the two horizontal stripes on the sides of the muzzle were more decidedly marked, and gave it a stronger expression of ferocity. The hogs of the Paramos, which are mountains at least 8,200 feet above the level of the sea, approach much more

nearly in appearance to the wild boar of the European forests, from the thickness of their hair, which has even become frizzled. Beneath, in some individuals, it has been observed to assume a woolly appearance. The hog of these elevated regions is, however, small and stunted, from the want of sufficient food, and the continued action of an excessive cold. In some sultry districts, the hog is not black, like those above described, but red, like the peccari, during its youth. At Melgar, and in the other places above mentioned, instances have been known where the hogs are not entirely black ; but these are comparatively rare. There is a variety called *cinchados*, or ' girthed,' because they have a large white band underneath, which usually unites on the back, and always preserves a uniform breadth ; and the young individuals of this variety bear the same stripes as those of the pure black breed. The only hogs in Colombia which resemble the common pigs of Europe, have been imported within the last twenty-five years, and these do not come direct from Europe, but from the United States of America ; and it must be recollected that in the neighbourhood of New York, where this race has long been domesticated, it experienced the influence of a climate very nearly the same as our own.

The horse has become wild in several districts of Colombia, especially in the plains of San Martin, among the sources of the Meta, the Rio Negro, and the Umadea, where small troops of chestnut horses may be observed. Their limited numbers, the narrow range to which they are confined, and the immediate neighbourhood of the inhabited districts, have prevented them from acquiring those peculiarities which Azara has related of the wild horses of Paraguay. They go about in small squadrons, composed of an old horse, five or six mares, with some foals, and one squadron is completely isolated from another. Instead of approaching the caravans to entice the domestic horses, they run away on the first appearance of a man, and do not stop their flight until he is out of sight. Their movements are graceful, especially those of the leader, but their forms, though not heavy, are wanting in elegance. In the Hatos des Llanos, the horses are almost wholly left to themselves. The herds are assembled together at intervals to prevent them from becoming absolutely wild, to extract the larvæ of the gad-fly, and to mark the foals with a red-hot iron. From this independent kind of life, they begin to acquire the uniform colour of the savage races. The chestnut bay is not merely the prevalent colour, but it is very nearly the only one. Something similar to this has probably happened in Spain with the wild horses (*cavallos cerreros*) which wander in the mountains ; for in the Spanish proverbs, the horse is often noticed by the name of *el bayo* (the bay), as well as the ass by the term *rucio* (grey). In the small Hatos which are found on the plateau of the Cordilleras, the effects of domestication are more perceptible. The colours of the horses become more various ; there is also a greater difference in their height ; and while many are more diminutive than the average of the species, only a few surpass the medium size. As long as they live continually in the fields, their hair is tolerably thick and long, but a few months' residence in the stable is sufficient to render it short and glossy. It is customary to cross this breed of horses with the races from the warm valleys, especially with those of Cauca. On some properties where this precaution has not been attended to, the horses have become perceptibly smaller, though the pastures have long been celebrated for their richness. The hair has grown to such a degree as to render their appearance absolutely deformed. In respect to the useful qualities, this breed has lost but little ; and the horses belonging to one canton are even celebrated for their swiftness. When a horse is brought from the Llanos de San Martin, or from Casanare, to the plateau of Bogota, he must be kept in the stable until he is accustomed to the climate. If allowed to run loose at once into the fields, he grows thin, contracts a cutaneous disease, and often dies in a few months. The pace which is commonly preferred in the saddle-horses is the amble ; this they are made to acquire early, and the greatest care is taken not to allow them, when mounted, to take any other pace. In a short time, the limbs of these horses usually become stiff ; and then, if otherwise of a good form, they are allowed to run in the Hatos as stallions. From them a race has descended, in which the amble is with the adults the natural pace. These horses are called *aguilillas ;* and they form a remarkable instance of the transmission of acquired habits from the parent to his offspring.

The ass has undergone very few alterations in its form or habits in all the provinces visited by M. Roulin. At Bogota it is very common, being there used for transporting building materials ; but being badly taken care of, and exposed to the inclemencies of the weather, without receiving sufficient nourishment, the race has become small and pitiful. It is covered with very long and uncombed hair. Deformed individuals are often seen, not only among the adults, which are loaded prematurely, and before they have acquired sufficient strength, but also among the foals at their birth. Perhaps the latter circumstance may arise from the ill treatment of the dams during the period of gestation. In the low and warm provinces this animal is less neglected, as it is required for the production of mules. Being well fed, at least in these districts, it becomes larger and stronger ; its hair also is shorter and more polished. In no province, however, has the ass reverted to its wild state.

The sheep was originally transported to the New World from Spain ; and the earliest importation

appears not to have been the Merino variety, but another, which the Spaniards call *de lana burda y basta* (with wool coarse and rude). It is very common on the Cordilleras, at an elevation of 3,300 to 8,200 feet. In no place do the sheep appear to have escaped from the protection of man, and hence we find that their manners have undergone scarcely any change; nor can any alteration in their forms be observed, except a slight diminution of stature. Within the limits above defined, the sheep propagate readily, and almost without requiring any care; but the reverse happens in the hotter districts. It appears that in the plains of Meta it is very difficult to rear lambs; and no sheep are to be seen from the river to the foot of the Cordilleras, although their skin is very much in demand to make a kind of parchment, and that its price is as high as the hide of an ox. In the valley which separates the most eastern chain from the central, they may perhaps be sometimes seen, but always in small numbers. The females are not very fruitful, and the lambs are difficult to rear. There is one very curious phenomenon exhibited by the sheep of this district. The fleece grows upon the lambs in the same manner as in most temperate climates, provided they are sheared as soon as it has arrived at a certain degree of thickness, in which case the wool grows again, and continues to observe the same order. But if the favourable period for stripping the animal of its fleece be allowed to pass, the wool thickens and becomes matted together, it detaches itself in flakes, and finally leaves behind —not, as we might expect, a growing fleece, or a naked and diseased skin—but, a short, glossy, and compact hair, exactly resembling that of the common goat in the same climate.

Although the goat is evidently best fitted for a mountainous region, it seems to thrive better in the low and sultry valleys than in the more elevated regions of the Cordilleras. In the former districts it multiplies rapidly, generally bearing two young at a birth, often three, but never six, as some have been pleased to assert. Its height is diminutive, but in other respects its form has greatly improved. Its body is more slender, the shape of its head is more elegant, more pleasingly disposed, and usually less overloaded with horns. The agility of this animal, and its taste for climbing and leaping, are also singularly increased. In the public square of a village, M. Roulin has often seen them leaping more than four feet upwards to the mouldings on the pilasters of the church. The projecting place on which their feet rested was not three square inches; yet in this position, so difficult to preserve, they remained for hours together, without any other apparent object than that of warming themselves in the direct solar rays, as well as in those reflected from below. These goats are covered with short hair, very glossy and thick; and although they may be seen to possess all the shades of colour, yet the most common is fawn, with a brown stripe on the back, and black symmetrical marks upon the face. The she-goats of Europe strikingly exhibit the influence of domestication in causing a great enlargement of the udders; for this acquired character has entirely disappeared in the she-goats of America.

The establishment of the larger cattle in America must be dated, like that of the hogs, from the second voyage of Columbus to St. Domingo. In the latter place they multiplied rapidly, and the island soon became the nursery from which these animals were transferred to different points on the coast of the mainland, and thence to the interior of the continent. Although these numerous exportations must have diminished their numbers considerably, yet we are informed by Oviedo, that within twenty-seven years from the discovery of St. Domingo, herds of 4,000 head of cattle might frequently be encountered, and that there were even some containing at least 8,000. In the year 1587, the number of hides exported from this island alone amounted to 35,444, while 64,340 appear to have issued from the ports of New Spain. This was the sixty-fifth year after the capture of Mexico, before which event the Spaniards were entirely occupied in warfare, and it strikingly evinces the extreme rapidity with which these animals will increase their numbers when placed under favourable circumstances. While the cattle were in small numbers, and grouped around the habitations of their masters, they succeeded equally well almost everywhere; but as soon as their numbers became greatly increased, it was discovered that in certain districts they could not exist without the assistance of man. Unless they were able to find a certain quantity of salt, either in the substance of the plants which formed their food, or in the streams which in some districts acquire a brackish taste from the saline particles contained in the soil, it was found to be absolutely necessary to furnish it to them directly. If this precaution were not attended to, they became stunted and poor; many of the females ceased to be fruitful, and the herds rapidly disappeared. Even in those districts where the cattle can exist without this assistance, it has been found advantageous to distribute salt at stated intervals to the herd. This is one principal means of attaching them to a particular spot; and so great is the avidity with which they take this substance, after being for some time deprived of it, that when it has been distributed to them two or three times at the same place, they are seen running from all quarters to the spot as soon as they hear the horns which the herdsmen sound before making the distribution. If, however, the country yields a sufficient supply of salt, and if the herdsmen neglect to assemble the cattle from time to time, they become in a very few years wholly wild.

This has happened at two places to M. Roulin's knowledge, the one in the province of San Martin, in a property belonging to the Jesuits, at the time when this religious order was expelled, the other in the province of Mariquita at Paramo de Santa Isabel, in consequence of the abandonment of some works where the natives washed for gold. In the latter place, the cattle have not remained in the districts where they were originally placed, but have mounted the heights of the Cordilleras to seek the region of the grasses, and there live in a temperature almost uniform of 48° to 50° Fahrenheit. To this spot the peasants of the villages Mendez, Piedras, and some others situate in the plains, sometimes come to hunt them. They drive with knotted cords small divisions of the herd towards the places where snares have been previously prepared. Whenever they obtain possession of one of these animals, it is often impossible to conduct it alive from among the mountains. This does not arise from the resistance which the captive makes, for after a little time its violence begins to diminish; but when the animal begins to perceive the futility of its efforts to escape, it is often seized with so great a tremor over the whole body, that it falls to the ground; to make it rise becomes impossible, and it dies in a few hours. The want of salt to preserve the meat, the distance from any inhabited district, and the difficult nature of the roads, prevent the hunters from deriving any other advantage from the slain animal than the portion which they can consume upon the spot. These disadvantages render the hunting of wild cattle by no means frequent; and the hunters always run the risk of being surprised by the snow, which often falls in these elevated regions. When the snow lasts many days, these unfortunate men, accustomed to the continual warmth of the adjoining valleys, are sure to perish. If, however, they are so fortunate as to bring one of these animals from the mountains, it is not difficult to tame; this is effected by confining it near to the farm, by supplying it regularly with salt, and habituating it to the sight of men. M. Roulin never had an opportunity of seeing one of these animals alive, but he tasted the flesh of a wild calf which had been killed on the evening of his arrival. Its flavour did not in any respect differ from that of the common domestic calf; the hide was remarkably thick, in other respects of the usual size; the hair was long, thick, and rough. In the province of San Martin he, however, saw a wild bull of a chestnut colour, pasturing in the Llanos in the midst of the domestic cattle. The wild bulls pass the morning in the woods which cover the base of the Cordilleras, and do not appear in the Savannah until about two hours after noon, when they come out to feed. As soon as they perceive a man, they hasten to regain the forest at a full gallop. The hide of the wild bull does not appear to differ in any respect from that of the domestic cattle which inhabit the same districts. In both they are much heavier than the hides of the cattle brought up on the plateau of Bogota, and the latter yield in this respect, as well as in respect to the thickness of their hair, to the wild cattle of Paramo de Santa Isabel. In the warmest parts of the provinces of Mariquita and Neyba, there are some herds of horned cattle with their hair extremely scanty and fine; they are given, by antiphrasis, the epithet of *Pelones*. This variety is transmitted to their descendants, but no care is taken to preserve the breed, as the Pelones are unable to bear the cold of the elevated regions of the Cordilleras, where the cattle intended for consumption or exportation must remain for some time to fatten. There is also another variety of cattle in this district called *Calungos*, having the skin entirely naked like the Barbary dog. As these animals are more feeble and delicate, it is usual to kill them before they are old enough for breeding. These never appear in the cold districts.

In Europe, where the milk of the cow forms a very important article of rural economy, it is usual to milk her continually from the moment of the birth of her first calf until she ceases to be fertile. This practice, continually repeated upon all these animals for a long series of generations, has had the effect of producing permanent alterations in the species. The udders have acquired an extraordinary size, and the milk continues to be secreted even after the calf has been removed. In Columbia, however, the introduction of a new rural system, the abundance of cattle in proportion to the number of inhabitants, their dispersion in pastures of very great extent, and a number of other circumstances which need not here be detailed, have counteracted this effect of domestication. The organization and function of the udder soon resume their original state when freed from the long-continued influence of habit. At present if a cow of Columbia be intended to yield milk for the dairy, the first care must be to preserve the calf; it is allowed to remain along with its mother for the entire day, during which she is permitted to suckle it. They can be separated only at night, and the milk secreted during the interval of their separation alone becomes available for economical purposes, and accordingly it is abstracted every morning. If the calf happen to die, the secretion of the milk is immediately stopped.

SPECKLINIA. A genus of ornamental, tropical, epiphytous plants, of the orchis order. It comprises a number of species which have been commonly but mistakenly assigned to the genus dendrobium.

SPECULARIA. A genus of ornamental, hardy, annual plants, of the bellflower family. It was recently constituted out of the genus prismatocarpus, just as that was constituted out of the genus campanula; and it takes for its type

the well-known Venus's looking-glass, called by Linnæus *Campanula speculum*.

SPEED. Inflammatory fever in cattle. See the article Inflammatory Fever.

SPEEDWELL,—botanically *Veronica*. A large genus of ornamental plants, of the figwort order. Eighteen species grow wild in Britain; about 120 species have been introduced from other countries; and about 50 more are known. Some have perennial roots and terminal clusters; some have perennial roots and lateral clusters; and some have annual roots and solitary axillary flowers. A small number are greenhouse evergreen undershrubs; a small number are greenhouse evergreen herbs; about twenty are hardy annuals; and nearly all the rest are hardy, annual-stemmed, herbaceous perennials. A few have a height of from 4 to 8 feet,—and a few have a height of only from 1 to 4 inches; but the great majority have a height of from 10 inches to 3 feet. A few have white flowers; a considerable number have flowers of some shade of pink or red; and nearly all the rest have blue flowers. Most of the perennials are decidedly beautiful, and of very easy culture; and they thrive in any common garden soil, and are, for the most part, readily propagated by division of the plant.

Two of the indigenous species are noticed in the articles Beccabunga and Bird's Eye.—The officinal species, *Veronica officinalis*, inhabits dry sandy banks, barren heaths, mountain pastures, poor woods, and waste grounds. Its root is perennial; its stems are cylindrical, prostrate, creeping, variable, and from 6 to 18 inches long; its leaves are elliptical, roundish, obtuse, and serrated; and its flowers grow in lateral clusters, and have a light blue colour with dark streaks, and bloom from April till July. The leaves of this plant have sometimes been used as a substitute for tea.—The spiked species, *V. spicata*, is a perennial-rooted indigen of the chalky pastures of England, and has a height of about a foot, and carries blue flowers from July till September.—The hybrid species, *V. hybrida*, is a perennial-rooted indigen of the mountains of some parts of England, and has a height of from 10 to 15 inches, and carries blue flowers from July till September.—The mountain species, *V. montana*, is a perennial-rooted inhabitant of the moist woods of Britain, and has a height of 6 or 8 inches, and carries blue flowers in July and August.—The bristled species, *V. setigera*, is a perennial-rooted indigen of the meadows of some parts of Scotland, and has a height of 3 or 4 inches, and carries blue flowers from April till July.—The saucer-leaved species, *V. scutellata*, is a perennial-rooted indigen of the marshes of Britain, and has a height of about 2 feet, and carries flesh-coloured flowers from June till August.—The pimpernel-like species, *V. anagallis*, is also a perennial-rooted indigen of the marshes of Britain, and has a height of about 2 feet, and carries blue flowers in July.—The shrub-like species, *V. fruticulosa*, is a perennial-rooted indigen of some of the lofty mountains of Scotland, and has a shrubby stem and a height of 6 or 8 inches, and carries flesh-coloured flowers from June till August.—The rock species, *V. saxatilis*, is also a perennial-rooted indigen of some of the lofty mountains of Scotland, and has a small, low, prostrate stem, and carries blue flowers in July.—The serpyllium-leaved species, *V. serpyllifolia*, is a small, prostrate-stemmed, perennial-rooted indigen of the meadows and pastures of Britain, and carries blue flowers from April till June. Five or six varieties of it have been introduced from Continental Europe.—The obtuse-leaved variety of the alpine species, *V. alpina obtusifolia*, is a perennial-rooted native of the Scottish mountains, and is small and creeping, and carries blue flowers in May. Five varieties of this species, and also the normal plant, have been introduced from Continental Europe.—The field or rural species, *V. agrestis*, is a small, creeping, annual weed of the cultivated lands of Britain, and carries blue flowers from March till July. Two varieties of it, the opaque and the various-coloured, also occur in our fields.—The corn-field species, *V. arvensis*, is a small creeping weed of old walls and other situations in Britain, and carries blue flowers from April till July.—The spring and the three-leaved species, *V. verna*, and *V. triphyllos*, are small, annual weeds of the sandy fields of Britain, and carry blue flowers in April and May.—The ivy-leaved species, *V. hederæfolia*, is a small, creeping, annual weed of the cultivated lands of Britain, and carries blue flowers from March till June.

SPELT. See Wheat.

SPERGULA. See Spurrey.

SPERMACETI. A fatty substance prepared from a peculiar secretion of the cachelots or spermaceti whales. These animals are occasionally seen in the European seas, but chiefly inhabit the Southern Ocean. They are of a blackish colour in the upper part of the body, and white on the belly; and each, when full grown, measures on the average about thirty feet in girth at the thickest part of the head, and about sixty feet in length. Their head is very voluminous, and has proportionally a far greater size than the body; the upper jaw has no whalebone and either no tooth or a very small and unprojecting one; the under jaw is narrow, elongated, and armed on each side with a range of conical or cylindrical teeth, which, when the mouth closes, are sheathed in cavities of the upper jaw; the cranium or brain-depository is situated in the posterior part of the head, and is rather small; and large cavities, separated and covered by cartilages, and filled with a spongy oily mass, which becomes fixed as it cools, occupy most of the superior part of the enormous head, and send off oil-filled ducts in ramifications through several parts of the body and through the blubber. The common spermaceti oil of commerce, similar

in appearance and properties to common whale oil, but of finer quality, is obtained from the spongy oily mass of the cavities, by digging it out and dripping it; and spermaceti itself, by first powerfully compressing the mass, next purifying the solid hard product by boiling in water, next subjecting it three times to the washing action of a weak ley of potash, and next concreting it in cooling vessels. Purified spermaceti commonly occurs in flaky or crystalline plates of a white colour and silvery lustre; it is brittle, and feels soft and slightly unctuous to the touch; it has no taste, and scarcely any odour; it is insoluble in water, but dissolves in about thirteen times its own weight of boiling alcohol; and it liquefies at a temperature a little below 212° Fahrenheit, and evaporates, a very little altered, at a temperature of 500°. It saponifies with pure potash, and then generates an acid to which Chevreul gave the name of cetic acid. Spermaceti is used by pharmacists in the compounding of several ointments, and sometimes by physicians as a demulcent and an emollient.

SPERMACOCE. See Buttonweed.

SPHAGNUM. A genus of mosses, of the gynostomous tribe. Four species, all of a yellowish green colour, grow in the bogs of Britain at all seasons of the year; and one of these, the blunt-leaved, comprising the three varieties, common, smaller, and floating, is one of the most abundant and most generally diffused of our bog mosses. See the article Bog.

SPHENOGYNE. A genus of exotic, ornamental, yellow-flowered plants, of the sunflower division of the composite order. About a dozen species, varying in height from 6 to 20 inches, four of them annuals, and the rest evergreen undershrubs, and the greater number very handsome, have been introduced to the gardens of Britain, principally from the Cape of Good Hope; and the ligneous kinds love a soil of loam and peat, and are propagated from cuttings.

SPICKNEL,—botanically *Athamanta*. A genus of plants, principally herbaceous and white-flowered, of the umbelliferous order. Upwards of a dozen species, varying in height from 1 foot to 5 feet, have been introduced to Britain from Siberia, Continental Europe, and the Levant; and all thrive in any common garden soil, and are propagated from seeds.

SPIDER. The aranea genus or araneides family, or spinner group, of the pulmonarious order of arachnides. See the articles Insects and Red Spider.

SPIDERWORT,—botanically *Tradescantia*. A genus of ornamental exotic plants, of the commelina family. Several hardy annuals and biennials, several hardy annual-stemmed herbaceous perennials, and upwards of a dozen tropical evergreen herbaceous species, have been introduced to the gardens of Britain; and most love a soil of rich mould, and have a height of from 10 to 30 inches, and carry blue flowers in the latter part of summer. The Virginian species, *Tradescantia Virginica*, one of the hardy perennials, was the earliest introduced, and is the best known, and may serve as a sufficient specimen of the whole. "The root," says Miller, "is composed of several fleshy fibres, which spread wide on the ground, from which arise many long, narrow keeled leaves, which embrace each other at their base. They are about half an inch broad at the bottom, and gradually lessen to a point; they are veined and rough on their edges, of a greyish colour and succulent. Between the leaves arises a thick jointed stalk about a foot long, garnished at each joint with one leaf, whose base embraces it. At the top of the stalk are two leaves which spread asunder; above these come out many flowers almost in a sort of umbel; these have a three-leaved empalement, and three large roundish petals of a deep blue colour, which in the morning spread open flat, but in the middle of the day they shrink up, and do not open again. But there is a succession of flowers from the same bunch daily, for a considerable time. The germen swells to a roundish capsule with three angles, having three cells, including a few angular seeds. It flowers in June, and there is commonly a succession of flowers for two months on the same plant, especially in cool moist seasons." Five varieties of it occur in gardens,—the double-flowered, the pilose, the white, the red, and the blue and white.

SPIGELIA. A genus of exotic herbaceous plants, of the gentian family. The Maryland species or worm-grass, *S. marilandica*, is a medicinal plant, and has a place in all the British pharmacopœias. It is a native of the warmer parts of North America, and was introduced to the gardens of Britain towards the close of the 17th century. Its root is perennial; its stems are annual, simple, erect, quadrangular, rough, rigid, and about 6 or 8 inches high; its leaves are opposite, sessile, ovate-lanceolate, entire, smooth, and spreading; and its flowers grow in solitary spikes, and have a bright red colour without, and a deep orange within, and bloom in July and August. The root is the medicinal part, and is most active in a recent state. It has a bitter taste; and acts as a narcotic, an anthelmintic, and a purgative; and is administered either in substance or in the form of aqueous infusion.

SPIKED-ROLLER. See Roller.

SPIKENARD (Ploughman's). See Baccharis.

SPIKE-RUSH, — botanically *Eleocharis*. A genus of rush-plants, of the cyperaceous order. Three species grow wild in Britain; seven or eight have been introduced from North America, Australia, and Continental Europe; and about twenty more are known. They are principally bog plants, more curious than either beautiful or useful; and all the species in British collections are perennials of between 3 and 15 inches in height. The three indigenous species are *E.*

palustris, *E. multicaulis*, and *E. acicularis*; and all bloom in July.

SPILANTHES. A genus of tropical herbaceous plants, of the sunflower division of the composite order. Seven or eight annual species, principally yellow-flowered and from 6 to 18 inches high, have been introduced to Britain; and one of these, *S. oleracea*, is used in India as a culinary plant, and is known there under the name of the cress of Para. It is perfectly hardy, and ripens its seeds in the open air at Paris.

SPINACH, — botanically *Spinacia*. A small genus of herbaceous plants, of the goosefoot family. The common pot herb species, *Spinacia oleracea*, is the well known culinary spinach, cultivated in kitchen gardens for sake of its large succulent leaves. It is of uncertain origin, but is known to have been cultivated in Britain since soon after the middle of the 16th century. It is an annual, and comprises two very distinct varieties, the prickly and the smooth. Its stems are hollow and branching, and rise to the height of about 18 or 24 inches; the leaves of the prickly variety are triangular and shaped like the point of an arrow, and those of the smooth variety are round and more succulent; the male flowers come out in long spikes, and are apetalous and of a herbaceous colour, and shed a profusion of yellowish pollen; and the female flowers grow on separate plants, and sit in clusters close to the stem at every joint, and are small, herbaceous, and apetalous, and comprise each a roundish compressed germen, which afterwards turns, in the prickly variety, to roundish seeds armed with short acute spines, and in the smooth variety to smooth seeds. Some subvarieties of the prickly kinds occur, with different size and shape of leaves, and with different degrees of prickliness in the seeds. The smooth variety is more impatient of cold than the prickly variety, and is raised for spring and summer crops, and loves a rich, moist, mouldy loam, in an open situation; and the prickly variety is raised for autumn and winter crops, and loves a light, dry, moderately fertile soil, in an open situation in the warmer season of the year, and in a sheltered border in the colder season. The ground, in every case, ought to be well dug and very thoroughly pulverized. Sowings of the smooth variety may be made every week or fortnight or month from the beginning of February till the end of summer, either broadcast or in drills nine or twelve inches apart; and sowings of the prickly variety may be made for a main crop in the early part of August, and in successions for about a month, either broadcast or in shallow drills six or twelve inches apart. The seed should be sown thin, the broadcast sowings regularly raked, and the drill sowings thinned and weeded.

SPINACH (New Zealand). See New Zealand Spinach.

SPINACH (Wild). See Goosefoot.

SPINDLE-TREE,—botanically *Euonymus*. A genus of ornamental shrubs and small trees, of the staff-tree tribe. One species, the European, grows wild in the hedges of Britain, and at the same time is a favourite plant in shrubberies and pleasure grounds; about twenty species have been introduced from North America, Austria, Caucasus, India, Nepaul, China, and Japan; and at least ten more are known. One or two of the introduced species are hardy evergreens; several are frame or greenhouse evergreens; and the rest are hardy deciduous shrubs. These plants have inconspicuous flowers, and carry them in axillary bunches; but most have very distinct and beautiful foliage, and make a pleasing figure in shape, habit, and general appearance.

The European spindle-tree, *Euonymus europæus*, is a deciduous shrub, or low tree, not often found much above 12 feet in height, but sometimes, in favourable situations, reaching even to 30 feet, and upwards. It has smooth branches, and opposite, lanceolate-ovate leaves, very minutely serrated, or saw-edged. The flowers are small, greenish white, somewhat star-shaped, produced from the axils of the leaves, and usually borne about three together on one peduncle or stalk; and they bloom in May; and are succeeded by handsome rose-coloured fruit, which ripen in September. It is found plentifully in Britain, and throughout the middle and north of Europe. There are four varieties of this species, *E. e. foliis variegatis*, which has sickly-looking variegated leaves; *E. e. latifolius*, with broader leaves than the normal plant; *E. e. nanus*, a dwarf growing variety, altogether smaller; and *E. e. fructu-albo*, which produces white instead of rose-coloured berries.

The broad-leaved spindle-tree, *Euonymus latifolius*, is a deciduous shrub, or low tree, of excellent habit, with smooth branches, large broadly-ovate leaves, and axillary-branched peduncles of small greenish white flowers, which are produced in June and July, and are succeeded by handsome scarlet fruit. It grows 10 or 12 feet high, sometimes more; and is one of the very handsomest of the genus, though, from being generally treated only as a small shrub, it is seldom to be found assuming its naturally interesting character. It is a native of Europe, and particularly of the south of Germany, and of France and Switzerland.

The warted-branched spindle-tree, *Euonymus verrucosus*, is a deciduous shrub, of rather a limited growth, seldom exceeding 10 feet, and assuming a conical outline, with warted branches, and ovate, serrated leaves. The flowers are borne about three on a peduncle, and have a greenish brown colour, and bloom in May and June. It is a native of Europe, particularly of Austria, Hungary, and Carniola.

The dark purple flowered spindle-tree, *Euonymus atropurpureus*, is a deciduous shrub of limited growth, introduced from North America, where

it was found on the banks of rivulets, from New York to Carolina. The branches are smooth; the leaves lanceolate, and serrated; the flowers small, dark purple, numerously produced on the peduncles from opposite sides of the stem, and appear in June and July, and are succeeded by red fruit.

The American spindle-tree, *Euonymus americanus*, forms a sub-evergreen small shrub, growing from 6 to 8 feet in height. The leaves are elliptic-lanceolate, and serrated; the branches smooth; the flowers small, yellow tinged with red, from one to three on a peduncle, produced in June and July; and they are succeeded by scarlet fruit which hang like those of the strawberry tree, and have a very gay appearance, and which occasion the tree to be called, in America, the burning bush. It is found in damp and shady places, in hedges, among rock, and on the borders of streams, in North America, extending from New England to Carolina.

The narrow-leaved spindle-tree, *Euonymus angustifolius*, is a small deciduous shrub, growing 5 or 6 feet high, with smooth branches, and leaves generally linear-elliptical, or oblong-elliptical. The flowers are small, usually solitary, of a yellowish red, as in *E. americanus*, to which plant it is nearly allied. It is found in shady woods, in Georgia, North America. It flowers in June.

Hamilton's spindle-tree, *Euonymus Hamiltonianus*, is a shrub or low tree, attaining 20 feet in height, and remarkable for the whiteness of its stem, and the large size of its leaves. It is scarcely hardy, having been killed to the ground by the winter of 1837–8, but sprang up again hardy, with vigour. It has an erect trunk and spreading branches, forming a dense fastigiate bush with numerous suckers. The branches are smooth; the leaves are lanceolate, and finely serrated; the flowers, yellowish green, in forked bunches, or cymes.

The obovate-leaved spindle-tree, *Euonymus obovatus*, is a trailing shrub, extending over a considerable circumference, but not often exceeding a foot in height. The stem is decumbent and rooting, producing upright angled shoots; the leaves are broadly obovate, obtuse, and finely serrated; the flowers, three in a bunch, and pinkish, and are produced in June and July. It inhabits marshy places in Pennsylvania.

The large flowered spindle-tree, *Euonymus grandiflorus*, is a deciduous shrub, growing from 8 to 10 feet high, with smooth branches, obovate-oblong serrated leaves, and large white flowers, in June, succeeded by pendulous clusters of yellow fruit. It inhabits the forests of Nepaul.

The Japan spindle-tree, *Euonymus japonicus*, is a handsome evergreen shrub, nearly hardy, having been but little injured by the winter of 1837–8, when planted against a wall, and standing out in ordinary winters with very little protection. It has obovate, dark green shining leaves, and whitish or pinky flowers, which are produced in July. The plant is not usually, in this country, of very large growth; but in Japan, where it is a native, it grows 20 feet and upwards. There is a variety called *E. j. foliis variegatis*, which differs in having variegated leaves; and has been found to be more hardy than the normal plant.

These plants are usually increased either by seeds, which are produced abundantly, by cuttings, or layers, which root freely, or by grafting or inarching, in the case of newly-introduced or rare kinds. Seeds and cuttings, however, are the most usual modes of propagation; and in raising plants in this way, nothing is required beyond the ordinary method of carrying this operation into practice. Some of the species, as *E. europæus* and *E. verrucosus*, are best suited for the company of large and common shrubs,—where, however, if not planted too closely with the other trees, they will individually attain considerable size, and become rather interesting than otherwise. All the commoner deciduous European species grow very freely in the ordinary soil of gardens, without the least difficulty. The North American species are more difficult to cultivate; they appear to grow naturally in damp shady woods, and on the margins of streams, and hence require more moisture and shade than are usually afforded them in this country. Some are even found in marshes, and would consequently require the characteristic features of the native localities to be imitated in artificial cultivation. These appear, also, to prefer a soil rather sandy or peaty; and hence, perhaps, the kinds of soil and situations usually provided for rhododendrons, and similar plants, would be found most suitable for these. The kinds which succeed best under this mode of treatment, are *E. americanus*, *E. atropurpureus*, *E. angustifolius*, and *E. obovatus*. The Nepaul, or Indian species, and *E. japonicus* and its variety, the most desirable plants of the family, inhabit, for the most part, mountains of considerable elevation, and require, in their artificial management, to be provided with a soil as little subject to superabounding dampness as can be provided. Situations, however, which are usually devoted to the growth even of common shrubs, are generally sufficiently drained to secure all that these plants require. *E. japonicus*, and its variegated variety, are suitable plants both to plant out as specimen bushes on a grass plat, in sheltered situations, and to plant against walls or buildings which it may be desirable to cover with a perennial foliage.

SPINE. The backbone or vertebral chain of a vertebrated animal. It commences with the bone which supports the head; and is continued in the bones of the neck, the back, and the loins; and, in most species, is prolonged beyond the posterior members, in the small bones of a tail. Its vertebræ work upon one another in sockets,

and are perforated by a canal or prolonged annular opening in which is lodged the spinal marrow or great nervous medullary cord. The combination of strength and mobility, of bone and muscle, of circulatory vessels and nervous processes, of earthy matter and cartilage and flesh and fluid, of the most diversified and mighty functional powers in the structure of the spine, viewed both in itself and in its connexions with the entire organization of the body, constitute a perfect museum of wonders, and afford multitudinous and overwhelming displays of the wisdom and goodness of the Creator, and present a brilliant field of study to at once the anatomist, the physiologist, the moralist, and the physico-theologian. Fracture of the horse's spine sometimes occurs in leaping a ditch, in struggling during a painful operation, or on other occasions of sudden and severe contortion; and it is always fatal.

SPINE. A sharp, indurated, terminating point in the leaf or calyx of a plant. It is well exemplified in the piercing armature of the thistles. Some spines are mere processes from the angles or apexes of leaves; and others, as in the common furze, may be regarded as comprising the whole bulk and substance of the leaves. Prickles and thorns differ from spines in their constituting an armature of the stems and branches of plants; and prickles issue merely from the bark, and are stripped off along with it, while thorns issue from the wood, and occur only on ligneous plants, and may be regarded as abortive and indurated buds.

SPIRÆA. A genus of ornamental plants, of the rosaceous order. Three species grow wild in Britain; and upwards of forty have been introduced from other countries, principally North America, Siberia, and Eastern Europe. A few are hardy, perennial-rooted herbs, propagable by division of the plant; and all the rest are hardy deciduous shrubs, varying in height from 1½ to 8 feet, and propagable in some instances from layers, and in others from suckers. A few have red or pink flowers; and nearly all the rest have white flowers. Two of the indigenous species are noticed in the articles Meadow-Sweet and Dropwort; and one of the introduced species, in the article Goats'-Beard.

The willow-leaved species, or common spiræa, or spiræa frutex, *S. salicifolia*, occurs wild in some of the woods of Britain, but has been introduced, in several varieties, from Russia and Tartary, and ranks as an ornamental plant in gardens and pleasure-grounds. It is a deciduous shrub, of commonly about 5 or 6 feet in height. The root is spreading, and sends up a profusion of stems and suckers. The old stems are branching; and the suckers of a single season's growth are as high in autumn as any of the stems. The bark of all is smooth; that of the old stems is red, though for the most part clouded with a dusky matter; that of the shoots from the stems is lighter yet reddish; and that of the suckers from the root is white. The leaves grow without order on the branches, and have a fine green colour, and are spear-shaped, obtuse, naked, and serrated. The earliest flowers are produced in June, at the ends of the branches which grow from the main stem; and before these cease to bloom, flower buds appear at the ends of the suckers, and are generally larger and fairer than those of the stems, and often keep up a succession of bloom till late in autumn. The flowers are produced in double branching-spikes, which are broadest toward the base, and diminish gradually upward, and end obtusely at the top; and they are of a pink or pale red colour; and, though individually small, yet, in consequence of being aggregated in these thick spikes of 4 or 5 inches in length, they have a good appearance. Five varieties of this species occur in collections,—the white, the alpine, and the broad-leaved, all with white flowers,—the large-flowered, with pink flowers,—and the flesh-coloured, with carmine flowers.

The tomentose or downy spiræa, *S. tomentosa*, is a native of North America, and was introduced to Britain in 1736. It is a deciduous shrub of about 5 feet in height. Its stems possess a considerable degree of downiness; its branches are covered with a purple bark; its leaves grow irregularly on the branches, and are ovate-lanceolate, unequally serrated, fine green above, and downy below; and its flowers grow in double branching spikes at the ends of the branches, and have a bright pink or red colour, and bloom from July till September, and make a fine appearance.

The hypericum-leaved spiræa, or hypericum frutex, *S. hypericifolia*, is a native of Canada, and was introduced to Britain in 1640. It is a deciduous shrub of five or six feet in height; and it has great beauty and elegance,—not so much from its natural form of growth, or from the colour of the bark or leaves, as from the flowers; for the branches are produced irregularly. The older shoots are covered with a dark brown bark; the younger shoots are smooth and lighter, and are tinged with red. The leaves are small, though of a pleasing dark green colour, and they come out irregularly and are entire. The flowers are produced in May, almost the whole length of the branches, and are of a white colour; and though separately small, they are collected in umbels which sit close to the branches, and ornament their whole length, so that scarcely anything but flowers, and the main stalks, are to be seen. The shrub, in fact, has the appearance of one continued flower, branched out into as many different divisions as there are twigs,—every twig looking at a little distance like a long narrow spike of flowers; and these being all over the shrub and of a pure white, they make a delightful show.

The sorbus-leaved spiræa, *S. sorbifolia*, is a na-

tive of Siberia, and was introduced to Britain in 1759. It is a deciduous shrub of 3 or 4 feet in height. Its young branches are clothed with a purplish bark; its leaves are beautifully pinnated, and closely resemble those of the service-tree; its folioles are oblong and uniformly serrated, and generally amount to about four pairs on each leaf, and are exceedingly ornamental; and its flowers grow in panicles at the ends of the branches, and are white, and bloom in August. A variety called the alpine, *S. s. alpina*, is comparatively dwarfish.

The opulus-leaved spiræa, or Virginian guelder rose, *S. opulifolia*, is a native of North America, and was introduced to Britain in 1690. It is a deciduous shrub of 7 or 8 feet in height. The branches are covered with a dark brown bark, which peels off in winter, and discovers an inner, which is smooth and of a lighter colour; so that in winter this shrub has a very ragged look. The leaves resemble those of the common currant bush, which has occasioned its being called by some the currant-leaved guelder rose; they are for the most part lobed like them,—though all are not alike, some being divided into more than three lobes, whilst others are scarcely divided at all; and they are serrated and of a palish green colour, and stand irregularly on the branches, on long green footstalks. The flowers are produced in June, at the ends of the branches; they are white at their first opening, and afterwards receive a reddish tinge, which is still heightened before they die off; and though each is rather small, and stands on a separate footstalk, many of them grow together in large umbels; and they are succeeded by bunches of reddish, cornered fruit, which make a pretty show in autumn. A variety occurs called the small woolly,—*S. a. tomentella*; and this is propagated from suckers,—the normal plant from layers.

The crenated-leaved spiræa, *S. crenata*, is a native of Podolia, and was introduced to Britain in 1739. It is a deciduous shrub of from 2 to 4 feet in height. Its branches come out irregularly, and are covered with a dark brown bark; its leaves are small, serrated, and of a pleasant green colour; and its flowers grow in roundish bunches on the sides of the branches, and are so profuse and plentiful as to cover almost all the branched part of the shrub, and have a white colour, and bloom in April and May, and make a handsome appearance.

Some of the most interesting of the remaining species are the germander-leaved, *S. chamædrifolia*, 20 inches high, white-flowered, blooming in June and July, introduced in 1789 from Siberia, and comprising four or five varieties from Germany, Hungary, and Canada; the elm-leaved, *S. ulmifolia*, 3 feet high, white-flowered, blooming in June and July, introduced in 1790 from Carniola, and comprising a variety called the leafy; the pretty, *S. bella*, 2 feet high, red-flowered, blooming in July and August, and introduced in 1820 from Nepaul; the meadow-rue-like, *S. thalictroides*, 2 feet high, white-flowered, blooming from May till July, and introduced in 1816 from Dahuria; the smooth-leaved, *S. lævigata*, 4 or 5 feet high, red-flowered, blooming from April till June, and introduced in 1774 from Siberia; and the three-lobed, *S. trilobata*, 3 or 4 feet high, white-flowered, blooming in May, and introduced in 1801 from Siberia.

SPIRALEPIS. A genus of ornamental, Cape-of-Good-Hope plants, of the thistle division of the composite order. Four species, varying in height from 6 to 15 inches, all evergreens, classed by the old botanists with the genus gnaphalium, and severally carrying flowers of red, brown, purple, and purple and green, have been introduced to the greenhouses of Britain; and all love a mixed soil of sand and peat and loam, and may be treated in the manner of the other greenhouse "everlastings."

SPIRANTHES. See Ladies' Traces.

SPIRIT. See Alcohol.

SPIRIT-LEVEL. See Levelling.

SPIT DUNG. See Farm-Yard Manure.

SPLEEN. A spongy, honey-comb-like organ, comprising numerous little cells and multitudes of minute vessels, and lying along the left side of the stomach of some of the higher orders of animals. It is one of the few organs whose precise functions have as yet baffled scientific research; but has been supposed to serve as a reservoir for any excess of fluid which the stomach receives and does not immediately require for any purpose of digestion. It is sometimes very much enlarged, and has even been known to be ruptured; but does not appear to be often or seriously the seat of disease.

SPLEENWORT. See Asplenium.

SPLENT, or Splint. A bony excrescence on the inside of the shank-bone of the horse. It seldom occasions lameness unless when so situated as to interrupt the motion of the knee-joint, or to interfere with the back sinew or suspensory ligament of the leg. In all ordinary cases, it may be let alone, or merely bathed with camphorated spirit or with spirit and vinegar; or even when it occasions slight lameness, it may generally be sufficiently cured or controlled by being for some time kept constantly moist with camphorated spirit or with spirit and vinegar through a swathing of soft linen; and only when it causes serious lameness or becomes very unsightly needs it be attacked with any appliance intended to remove it. The old barbarous practices of bruising a splent with a hammer, chopping it off with a mallet, cutting it off with a saw, boring it with a gimlet, sweating it down with hot oils, and slitting down the skin and the periosteum over it, are never necessary and ought to be avoided and abhorred. The strongest measure requisite for the removal of almost any bad recent splent is to shave off the hair, rub in a little strong mercurial ointment for two days, and afterwards

apply a blister, and perhaps also a second blister. But a new, ingenious, generally successful, and but slightly painful method of reducing splents has been introduced by Professor Sewell. "He removes any inflammation about the part by the use of poultices or fomentations; and then, the horse being cast, the operation is commenced by pinching up the skin, immediately above the bony enlargement, with the finger and thumb of the left hand, and with the knife, or lancet, or scissors, making an orifice sufficient to introduce a probe-pointed bistoury, with the edge on the convex side. This is passed under the skin along the whole length of the ossification beneath, cutting through the thickened periosteum down to the bone; and this being effectually completed by drawing the knife backwards and forwards several times, a small tape or seton is inserted, and if the tumour is of long standing, kept in during a few days. Perhaps slight inflammation may appear, which subsides in a few days if fomentation is used. The inflammation being removed, the enlargement considerably subsides, and in many cases becomes quite absorbed."

SPONDIAS. See Hog Plum.

SPONGE. A genus of coralliferous polypi. They are marine fibrous bodies, whose only sensible portion seems to be a kind of tenuous gelatine, which dries off when the bodies are removed from their habitat, and which leaves scarcely a trace of itself, and no trace whatever of any moving part or strictly true animal organism. A tremulousness or contraction is said to occur in living sponges when they are touched, and a kind of palpitation also is said to be observable in the pores or orifices of their surface; but the reality or at least the sentiency of these alleged motions is rather questionable. Sponges assume exceedingly different shapes, each according to its species, and present resemblances to shrubs, vases, fans, horns, tubes, globes, and other objects. The common or officinal sponge, called by scientific naturalists, *Spongia officinalis*, is familiar to almost every person. In its natural or living state, it is a flexile, fixed, torpid, polymorphous animal, comprising innumerable reticulate fibres or small mutually interwoven spires, clothed with a thin gelatinous flesh, full of small mouths, by which it absorbs and ejects water; and in its dead state, it remains nearly the same as before except for being freed from its functional gelatine,—but may be described as a brown mass of extremely fine, flexible, elastic fibres, perforated with numerous intercommunicating pores and little irregular canals. It is found principally in the Mediterranean and the Red Sea; and occurs on rocks and stones at considerable depths beneath the surface; and is obtained in large quantities by divers belonging to the islands of the Grecian Archipelago; and has long been imported to Britain in large quantities from Smyrna. In a well cleaned state, it is of great service in the practice of surgery, and in many of the cleaning operations of the stable, the farmery, the bath, and the bedroom,—being soft, light, and very porous, rapidly absorbing by capillary attraction either water or any other liquid in which it is immersed, and as readily parting with it by compression. When digested in boiling distilled water, it yields a considerable proportion of gelatine, and loses much of its flexibility, and becomes capable of crumbling when dry; when boiled with potash, it saponifies; and when burnt, it yields iodine and perhaps bromine. Its principal constituents are gelatine and albumen, with a small portion of common salt and some carbonate of lime. It is, of course, too expensive to be generally or normally used for manure; and when in any case it becomes available for that purpose, it needs first to be reduced in texture and considerably decomposed.

SPONGE-TREE,—botanically *Acacia Farnesiana*. A small, ornamental, fragrant, evergreen, tropical tree, of the mimosa division of leguminosæ. It was introduced to the hothouses of Britain from St. Domingo about the middle of the 17th century. Its stem rises to the height of about 15 feet; its leaves are bipinnate; its prickles are stipular and straight; and its flowers grow in globose heads, and have a yellow colour, and bloom from June till August.

SPONGIOLES. The pulpy and bibulous extremities of the fine fibres or extreme radicles of the roots of plants. They comprise each one or more central ducts or vessels, enveloped by a cellular tissue; but they have no epidermis or cuticle, and are supposed to consist of the nascent or newly-formed tissue of the root. They occur only at the extremities of radical fibres, and are constantly advancing or changing place with the growth of the radicles. They absorb the food of plants from the soil, and constitute the mouths of the radicles pushing onward in search of it, and take it in only in a liquid condition, and probably exert in some degree both an electric and a chemical power over the materials of it in the action of absorbing them, yet not to such an amount as to prevent them from being seriously controlled in their secretions, and even absolutely poisoned, by peculiar conditions of the soil. See the article Absorption in Plants.

SPOONBILL,—scientifically *Platalea*. A genus of birds, of the cultirostrous family of waders. Their general structure is near akin to that of the storks; but their bill, whence they derive their name, is long, flat, broad throughout, widened and flattened at the end so as to form a spatula-like disk, and has two shallow grooves extending from the base almost to the end, but without being parallel to the edges.—The white spoonbill, *Platalea leucorodia*, is an occasional visitant of the British shores, and one of the most singular-looking birds ever seen in our country. Its total length from the point of the bill to the tip of the tail is about 32 inches,—and the portion of this in the bill alone is about 9 inches; its en-

tire plumage, except a band of buff feathers at the bottom of the neck in front, is white; its occiput is surmounted by a crest or plume; and its bill, legs, toes, and claws are black. It feeds in a very similar way to storks, herons, and bitterns; and it occurs throughout the eastern continent, and builds there on high trees.

SPORADIC DISEASES. Diseases which occur only in particular subjects, or affect only particular constitutions or ages. Strangles, for example, is a sporadic disease of young horses; and distemper is a sporadic disease of young dogs. Sporadic diseases are contradistinguished, on the one hand, from specific diseases which attack only certain species or genera of animals, and, on the other, from epidemics and endemics which attack individuals of all ages and constitutions; and they form a very extensive class of diseases.

SPORE, or SPORULE. A microscopic, reproductive granule in cryptogamic plants, analogous in nature and function to the seed of a phænogamous plant. The spores of minute cryptogams, and even those of some of the comparatively large musci and fungi, are produced in prodigious numbers, and multiply with amazing rapidity; and being at the same time so light and minute as to float on every breeze and mingle invisibly with the common air, they become everywhere diffused throughout the atmosphere, and are always ready to sit down and grow wherever they can find a suitable nidus. The globules or pouches in which those of many species are contained, and which bear the name of sporidia, are themselves quite or almost microscopic; and yet a single sporidium of a dust fungus, such as that of smut, has been calculated to contain no fewer than ten millions of spores. See the articles ACOTYLEDONOUS PLANTS, CELLULARES, CRYPTOGAMOUS PLANTS, FUNGI, MILDEW, SMUT, and MOULD.

SPORIDIUM. See SPORE.

SPOROBOLUS. A genus of exotic grasses of the agrostis tribe. Three annual species, a biennial, and a perennial have been introduced to Britain from Australia and the two Indies; and they vary in height from 6 to 30 inches, and thrive in any common soil, and are all propagable from seeds; but they are more curious than useful.

SPRAIN. See STRAIN.

SPRAT. See FISH and RUSH.

SPRENGELIA. A small genus of ornamental exotic plants, of the epacris order. The flesh-coloured species, *S. incarnata*, is a small evergreen shrub of 2 or 2½ feet in height; and carries flesh-coloured flowers from April till June; and was introduced to the greenhouses of Britain about 55 years ago from Australia.

SPRING. The season which intervenes between winter and summer. It is the season of revival to dormant animals and sleeping plants, —of germination to seeds and arousal to roots and stems,—of upstarting to grasses and ex-foliation to trees,—of begun glee and singing to the songsters of the grove,—of transition from gloom and snow-storms to cheeriness and warmth and sunshine,—of the outburst of hope and activity from the outhouses of the farmery to the fields of the farm,—and of the commencement and large performance of the busiest and most significant processes of cultivation. But we have sufficiently indicated its phenomena and its peculiar occupations in the article CALENDAR; and we shall here do no more than quote from "Mudie's Spring" a description of the prognostics, characteristics, and sequences of a spring snow-storm, embodying the most intensely interesting group of meteorological events which can challenge the farmer's attention from beginning to end of the year:—

"On an evening, after a day of unwonted tranquillity, dense clouds appear like great snowy mountains in the western part of the horizon, while the few clouds which lie in streaks across the setting sun, are intensely deep in their shadows, and equally bright in their lights. As the evening closes in, the clouds disappear, the stars are unusually brilliant, and there is not a breath of air stirring. The old experienced farmer goes out to take his wonted nocturnal survey of the heavens, from which long observation on the same spot has enabled him to form a tolerably correct judgment of what will be the state of the weather in the morning. Two or three meteors,—brilliant, but of short duration,—shoot along a quadrant of the sky, as if they were so many bright lights of the firmament dropping from their orbits. He returns and directs his men to prepare for what may happen, as there will certainly be a change of the weather. The air is perfectly tranquil when the family retire to their early pillows, to find that repose which healthful labour sweetens and never misses,—

> 'Till rest, delicious, chase each transient pain,
> And new-born vigour swell in every vein.'

But just at the turn of the night, the south gives way, the north triumphs, and the whirlwind, herald of victory, lays hold of the four corners of the house, and shakes it with the shaking of an earthquake. But the house, like its inhabitants, is made for the storm, and to stand secure and harmless; while the wind thunders in the fields around, every gust roaring louder than another amongst the leafless branches of the stately trees. In a little its sound is muffled, without being lessened, and the snow is heard battering at the windows for an entrance,—but battering in vain. Morning dawns; but every lea and eddy is wreathed up; the snow still darkens the air, and reeks along the curling wreaths as if each were a furnace. For two days and two nights, the storm rages with unabated violence; but on the third day, the wind has veered more easterly, blows rather feebly, and though the snow falls as thickly, it falls uniformly over the whole surface. This continues for two or three days more; and on the coming of the last of these days, the sun, which has not been visible for nearly a week,

looks out just before setting, as if promising a morning visit. The night remains clear, with keen frost, and the wind steady at north, and blowing very gently. The sun rises bright in the morning,—the storm is over,—and the weather remains unbroken for four or five weeks. When the appointed days of the snow-storm are numbered, a disturbance again takes place in the atmosphere, but it is of a different kind from the former. There are little sheets of lightning playing momentarily in the lower atmosphere, and the lustre of the stars is diminished; but still there is no cloud. The wind, however, dies away to a dead calm towards evening, and all is ready for the breaking storm. That operation is the first performed by the spring, and we shall borrow the words of the 'British Naturalist' wherein to describe it:—'As the spring gets the mastery, which is aided by the condensation which takes place during the night, it rises to a wind, the sound of which cannot be mistaken. The rigidity of trees, window-frames, and other wooden fabrics through which it passes, is relaxed; the withered grass and reeds, when these are exposed, moisten; and the rattling and thumping are succeeded by murmuring harmony, in which, compared with the other, there is a good deal of music, and as the morning advances, and the animals come abroad, and man begins to be active, the hard metallic sounds are gone, and there is a softness about nature. There is always a delightful transparency about the atmosphere, because the little *spiculæ* of ice are gone, and the heat of the air is too much occupied in converting the snow and ice into water, for changing much of that into vapour. When the change is accompanied by rain, it is far more pleasant at the time, and there is a danger, almost a certain one, that the spring will be treacherous; and that, in consequence of the great heat required for melting the snow, and the evaporation of the rain together, frosts will return long before the process of thawing, so comparatively slow, is completed. The slow melting of snow by rain compared by that of a warm atmosphere, which is constantly shifting by the wind, can be easily understood when it is remembered that the water which falls, even if it had the temperature of the greatest summer-heat, would be cooled down to the freezing point in melting half its weight of snow. But as the temperature can only be a little above freezing, the water will have the temperature of 32° before it has cooled perhaps one-tenth of its weight; and as the water is a bad conductor of heat, and great part of the action of the oblique rays of the sun is reflected away from its surface, a rainy breaking of a storm is almost sure to be followed by frost, if it do not happen when the season is far advanced.' In such a situation, and under such circumstances, the storm not unfrequently passes away in what is emphatically termed a gentle thaw; and when this is the case, the spring comes under the most favourable circumstances. The snow is dissolved by atmospheric influence alone, without any rain from the clouds; although there are generally light clouds hovering about, ready to produce rain if a returning frost should render a contest of the elements necessary. Besides its rare pleasantness, the gentle thaw is attended with several beneficial consequences. In the first place, there is no flooding of the low grounds, and no washing of the soil from the more elevated ones; but the snow forms a trough for the discharge of the water into which it is melted, and thus the coldest of the snow-water does not reach the surface of the land. In the second place, the water produced by the melting of the snow sinks gradually into the earth, and the earth has been opened to receive a greater store than if it had been pelted by rain during winter. This is occasioned by the radiation of the heat from the lower strata of the earth, which is confined by the snow, and turned back again to act upon the earth. In the third place, this last circumstance produces a beginning of the spring under the shelter of the snow, which could not have taken place with free exposure to the atmosphere. The blade of the plant is protected, and the roots have heat and moisture, and the air is excluded from them. They are thus placed under the most favourable circumstances, and they are stimulated accordingly. The difference in this respect is very considerable; for if, owing to the action of the wind during the fall, or to any other cause, one portion of a field has been exposed to the air while the frost continued, and another covered by the snow, it will be found that vegetation upon the part which the snow covered will be fresh, green, and vigorous, long before that upon the exposed part shows any decided signs of action. This, by the way, is the real cause why spring is so much more rapid, and meets with so fewer reverses, where the winter is firm and decided, but of moderate length, than it does when the winter is variable."

SPRING. A natural fountain,—a stream of water issuing from the ground. It is fed by the percolation of surface water through porous strata in an elevation somewhere above it, and is caused by the obstruction or accumulation of the percolating water on a retentive stratum, forcing it along to find a vent in the crevice or porosity where the spring is situated. See the articles Artesian Well and Geology, and the section "Strata-Draining" of the article Draining. A spring may have any volume from a mere thread of water to an incipient river, according to the extent of percolating surface which it drains and to the moistness of the climate; and it may be either occasional, seasonal, or perennial, according to the circumstances of the percolation and the nature of the ground. Most springs, especially on hill sides and in upland districts, are cool and of comparatively uniform temperature, in consequence of the percolation which feeds them passing through great depths or wide expanses of strata, which are affected

little by solar heat, and not at all by subterranean heat; but some, especially in the vicinity of active volcanoes, or in districts subject to the action of earthquakes, where the percolation proceeds within the range of the subterranean fires, constantly possess a high temperature; and almost all springs, whether cold or hot, hold in solution, more or less abundantly, in more or less variety, and with more or less perceptibility in taste and colour, mineral substances derived from the strata through which the percolation occurs. See the articles WATER, MINERAL WATER, IRRIGATION, and FOUNTAIN.

SPRING. A mechanical contrivance for resisting percussion, regulating pressure, diminishing draught, or producing interior motion. It combines in a high degree strength and elasticity; and may consist of elastic steel or any similar substance. The spring of a watch is a familiar instance of a spring producing interior motion; and the springs of carriages, in all their numerous varieties, serve one or two or all of the three other purposes of springs. "Springs," says Mr. Giddy, "were in all likelihood first applied to carriages with no other view than for the accommodation of travellers; they have since been found to answer several important ends. They convert all percussions into mere increase of pressure; thus preserving both the carriage and the materials of the roads from the effect of blows; and small obstacles are surmounted when springs allow the frame and wheels freely to ascend, without sensibly moving the body of the carriage from its place. If the whole weight is supposed to be concentrated on springs very long, extremely flexible, and with the frame and wheels wholly devoid of inertia, this paradoxical conclusion will most certainly follow,—that such a carriage may be drawn over the roughest road without any agitation, and by the smallest increase of force. It seems probable that springs, under some modification of form and material, may be applicable with advantage to the heaviest waggon." "All stage coaches, and many travelling carriages," says Mr. Youatt, "hang upon grass-hopper springs, which allow of perpendicular without any longitudinal action. The more elasticity, or in other words, the more action there is in grass-hopper springs, the more effect it will produce in diminishing the draught; with a C spring a very contrary effect is produced. A carriage hung upon C springs may certainly be made the most comfortable to the rider; but all the ease that can be required, and much more than is found in the generality of post-chaises, may be obtained by well-constructed grass-hopper springs, and with considerable advantage to the horses. The practice of loading coaches as high as possible to make them run light, as the coachmen have found by experience, is only a mode of assisting the springs. The mass being placed at a greater height above the wheels, at the extremity of a long lever, is not so easily displaced laterally by any motion of the wheels, which, therefore, rise and fall on either side as they run over the stones, acting only on the springs, which restore the full pressure and velocity in descending, from the obstacle which was imparted to them in ascending, and without producing any sudden concussions upon the load, which swings to and fro with long easy movements. It is possible, also, that the weight, being thus swung from side to side, may, upon good roads, diminish the draught, as it is in fact generally running upon two of the wheels; while, in the other direction, it equally admits of the front and hind wheels successively passing over any impediment; and yet, by the manner in which it is fixed upon the springs, it does not admit of any longitudinal elasticity."

SPRING-FEED. Though the use of turnips in winter, and of artificial grasses on arable land in summer, has been carried to a high degree of perfection, yet a full, proper, systematic supply of succulent feed for young stock and for all non-fattening cattle, between the finishing of the turnips and the commencement of the grasses, is still, in a considerable degree, a desideratum; and this is what many farmers technically call spring-feed. Swedes have done much to afford the supply; but however palatable and nutritious for the main portion of stock, they entirely fail for the young, and do not always last long enough for the old. Every judicious breeder is desirous of training the young stock to keep themselves as soon as there is food of a proper quality available for them; and if the young lambs in particular are kept from green food until they are turned into the grass clover leys with their dams, there is great danger that a portion of them will be lost. It is generally desirable to keep the clover leys free at least until May, and long before that time the young stock should be trained to eat a considerable portion of green food. With the view of supplying this want, several plants have been cultivated for early feed in the spring, with greater or less success, or under greater or less disadvantage. The farmer who occupies a poor soil encounters peculiar difficulties; for lateness of vegetation and certain destruction of his crops of grass are sure to be the consequence if he break into them before they attain a proper degree of maturation, and yet he has also the greatest obstacles to surmount in cultivating any spring crop. The farmer, on the other hand, who cultivates rich fertile land where he has a deep alluvial soil, growing every crop luxuriantly, can easily free a pasture early in the autumn, and have it full of young grass as early as he may require it, and knows nothing of the difficulties which attend his less favoured neighbour. The avidity with which any new kind of forage plant promising early growth is tried, indicates how desirable a point it is to secure an early supply of succulent food. The crimson trefoil was tried;

but has generally been found a failure. Young furze is suitable enough on some store farms, for sheep of very hardy constitution; but is of very limited value in other circumstances. The winter tare is eminently useful, and affords a very great bulk of nourishment; but is rather a summer than a spring crop. A series of forage crops suitable alike for green food and for hay is of the highest consequence; but belongs rather to the system of soiling than to the simple provision of spring-feed. Some forage plants, as white mustard, make excellent feed for sheep, but are not equally suitable, or even not suitable at all, for cattle. Altogether, the best plants as yet tried for spring-feed are the luxuriant varieties of rye. See the articles Rye, Soiling, and Feeding of Animals.

SPRING GRASS. See Anthoxanthum.

SPRING WHEAT. See Wheat.

SPRIT. See Rush.

SPROUT-HILL. See Ant.

SPRUCE. See Fir.

SPUR. See Ergot.

SPURGE. See Euphorbia.

SPURGE LAUREL. See Laurel (Spurge).

SPURGE OLIVE. See Mezereon.

SPURLESS VIOLET. See Violet (Spurless.)

SPURREY,—botanically *Spergula*. A genus of herbaceous plants, of the carnation family. The calyx is five-segmented; the petals are entire and amount to five; and the seed-vessel is ovate, five-valved, one-celled, and many-seeded. Five species grow wild in Britain; several have been introduced from other countries; and a number more are known.

The common spurrey, or yarr, or pickpurse, *Spergula arvensis*, is an annual weed of the sandy corn-fields of Britain. Its stems are lax, spreading, jointed, angular, leafy, moderately branched, hairy and viscid in the upper part, and from 6 to 15 inches high; its leaves are whorled, subulate, narrow, obtuse, fleshy, and downy, and have short stipules; its floral footstalks are slender and downy, and become reflexed toward the period of the seed ripening; its flowers are white, and bloom from June till August; and its seeds are somewhat kidney-shaped, angular, rough, and of a black colour. This plant abounds on inferior light soils, which have been too finely tilled; and it is greedily eaten by all sheep and cattle, and appears to be very nutritious and wholesome, and is said to improve the mutton of sheep and the milk and butter of cows. Two very distinct varieties of it are much cultivated in Germany and Flanders as late pasture for sheep and cattle,—the one with large smooth seeds, called *S. a. sativa*,—and the other with a somewhat freely branching habit, called *S. a. ramosa*. The herbage continues green till a late period in autumn, and often throughout the winter; and it can either be used as pasture or cut for soiling or made into hay. The seeds also afford by expression a good lamp oil, and may be ground into flour which, when mixed with the flour of wheat or rye, is suitable for bread, and is often employed for that purpose in Gothland and Norway. Poultry eat spurrey in any form, and are thought to become very prolific of eggs when fed upon it. Von Thaer speaks of it as an eminently nutritious herbage; and not a few Continental agriculturists seem to think it an excellent crop. Notwithstanding all its recommendations, however, it does not appear to merit cultivation in Britain. We possess much more profitable plants for all the soils and situations which it would suit; and we have sometimes a great deal more than enough of itself in the unwelcome form of a weed.

The pentandrous spurrey, *Spergula pentandra*, is an annual weed of the sandy fields of some parts of England; and it has a height of 6 or 8 inches, and carries white flowers in June and July.—The knotty spurrey, and the awl-shaped spurrey, *Spergula nodosa* and *Spergula subulata*, are perennial weeds of the sandy heaths of Britain; they have a height of 6 or 8 inches, and carry white flowers in the latter part of summer.—The sagina-like spurrey, *Spergula saginoides*, is a perennial-rooted, creeping indigen of some of the lofty mountains of Scotland; and it carries white flowers from June till August.—Two of the introduced species,—the pale, *Spergula pallida*, a reddish flowered evergreen herb, from the Cape of Good Hope, and the larix-like, *Spergula laricina*, a white-flowered, tiny trailer, from Siberia—have an ornamental character, and deserve a place in the flower-border.

SQUASH. The melon-pumpkin,—*Cucurbita melopepo*. See the article Gourd.

SQUEAKER. A pigeon under six months of age.

SQUILL,—botanically *Scilla*. A genus of ornamental, bulbous-rooted plants, of the asphodel family. Four species grow wild in Britain; upwards of twenty have been introduced from other countries; and some more are known. They have radical and somewhat linear leaves; and carry their flowers in clusters, on the top of solitary naked flower-stalks; and look, in many instances, like miniature hyacinths; and have, in general, a very pretty appearance. Most have either blue or red or pink or white flowers; the great majority love a light soil, either of peaty loam or of sandy loam; and all are readily propagated from offsets.

The undescribed squill, or wild hyacinth, or harebell, *Scilla non-scripta*, abounds in the woods and groves and streamlet banks of many parts of Britain; and is one of the most beautiful of our wild flowers; and also holds a conspicuous place in many a flower border. Its flower-stem has commonly a height of about 8 or 9 inches; and its flowers are blue, and bloom from March till June. One variety of it, *S. n. alba*, has white flowers; and another, *S. n. carnea*, has flesh-coloured flowers. Its bulb, in common with that

of most or all of the other species, contains some acrid or poisonous matter,—whence is derived the names squill and scilla, from a word signifying to injure; but it also contains much useful mucilage, which can easily be separated from the acrid matter, and is extensively employed by calico-printers.—The spring squill, *Scilla verna*, grows wild in rocky situations in Britain; and has a height of 3 or 4 inches; and carries blue flowers in April and May. Two pretty varieties of it—the one with white flowers, *S. v. alba*, and the other with rose-coloured flowers, *S. v. rosea*—occur in gardens. — The two-leaved squill, *Scilla bifolia*, grows wild in the woods of some parts of England; and has a height of 3 or 4 inches; and carries blue flowers from February till April. Two varieties of it—the one with white flowers, *S. b. alba*, and the other with red flowers, *S. b. rubra*—have been introduced from the south of Europe.—The autumnal squill, *Scilla autumnalis*, grows wild in the dry pastures of some parts of England; and has a height of 3 or 4 inches; and carries pink flowers in August and September. Two varieties of it—the one much taller than the normal plant, *S. a. major*, and the other with white flowers, *S. a. alba*—occur in gardens.

Some of the most beautiful, or otherwise interesting, of the introduced species, are the campanulate, *S. campanulata*, a native of Spain, a foot high, carrying dark purple flowers in May and June, and comprising two varieties with respectively white and pink flowers; the Italian, *S. italica*, a native of Switzerland, 9 or 10 inches high, carrying blue flowers from April till July; the Peruvian, *S. peruviana*, a native of Southern Europe, a foot high, carrying dark blue flowers in May, and comprising a variety with white flowers; the Siberian, *S. sibirica*, a native of Siberia, 3 or 4 inches high, carrying blue flowers in February and March; the pleasing, *S. amœna*, a native of the Levant, 3 or 4 inches high, carrying light blue flowers in March and April; the hyacinth-like, *S. hyacinthoides*, a native of Madeira, rather tender, 6 or 7 inches high, carrying blue flowers in August; and the esculent, or quamash, *S. esculenta*, a native of North America, a foot high, carrying white flowers from May till July.

SQUILL ROOT. The bulb of *Ornithogalum squilla*. See the article ORNITHOGALUM. This bulb is medicinal, and has a place in the pharmacopœias. It is inodorous, bitter, and nauseous; and possesses so much acridity that, when much handled, it inflames and ulcerates the skin; but loses a considerable portion of both its acridity and its medicinal virtues by drying and long keeping. It consists, according to Vogel, of 30 per cent. of woody fibre, 24 of tannin, 6 of gum, 6 of saccharine matter, and 35 of a peculiar bitter principle called scillitina; and this principle, when separated, is white, transparent, and pulverulent, breaks with a resinous fracture, is very soluble in water and in alcohol, rapidly absorbs moisture from the atmosphere till it liquefies, and has an intensely bitter taste with a perceptible degree of sweetness. Squill root, in small dozes, is expectorant and diuretic,—in large doses, emetic and purgative,—and in over-doses, productive of strangury, bloody urine, cold sweating, and convulsion; and it is administered, in combination with other medicines, in asthma, dyspnœa, and dropsy, — and is also a principal ingredient in a number of expectorant pharmaceutical preparations, ordered in the pharmacopœias and kept in the drug shops.

SQUIRREL. A genus of mammals, of the order rodentia. They have four grinders, variously tuberculated, and a very small additional one above in front,—strongly compressed inferior incisors,—large head, with lively projecting eyes, —four toes before, and five behind, the thumb of the fore-feet sometimes marked by a tubercle,—and a long tail, furnished with hairs, and, in the case of the most characteristic, so spread out on the sides as to resemble a large feather. They are light and active animals, living on trees, and feeding on fruits.—The common squirrel, *Sciurus vulgaris*, is a well-known, lively, little inhabitant of the woods of Britain. Its back has a bright red colour; its belly is white; and its ears are terminated by a tuft of hair. It feeds on nuts, acorns, cones, buds, and young shoots of trees. The female constructs among the branches of trees a nest of moss and dried leaves, and brings forth from three to seven young in April or May.

SQUITCH-GRASS. See COUCH-GRASS.

STAAVIA. A genus of ornamental, calyciflorous, white-flowered, Cape-of-Good-Hope, evergreen undershrubs, of the brunia family. Three species, varying in height from 12 to 24 inches, and blooming in the early part of summer, have been introduced to the greenhouses of Britain; and they are heath-like and beautiful, and love a soil of peaty loam, and are propagated from cuttings.

STABLE. The size, arrangement, and furnishing of stables must considerably vary according to the circumstances of their owners, and to the number and quality of their inmates; and yet ought, in every instance, to be determined by certain great general rules for the promotion of convenience, cleanliness, ventilation, comfort, and health. Some hints for wisely constructing them on farm-steads are given in the article FARM-BUILDINGS; and instructions respecting their efficient management are contained in the articles HORSE, GROOMING, LIQUID MANURE, and FARM-YARD MANURE; so that, in this place, we have to concern ourselves principally with the statement and illustration of the most important of the general rules.

The site of every stable ought to be such as to ensure complete drainage, not only of all rain and snow water, but also and stringently of all

liquid affusion within, and especially of all urine. A perfectly and constantly dry stable is quite essential to the health and vigour of horses. "But," to adopt the words of Mr. Winter, "this is not the sole reason why the urine should be speedily conveyed away, for it not only keeps the flooring in a damp state, but fills the stable with gases highly deleterious to the health of the inmates, frequently acting as the predisposing or exciting cause of dangerous and contagious diseases, as acute and chronic cough, pneumonia, farcy, glanders, and inflammation of the conjunctival membrane of the eyes. It usually happens that the fluids of the stable are allowed to find their exit by an open paved gutter at the foot of the stall, or are suffered to be entirely absorbed by the litter, and removed with the dung when the stable is cleansed out. An under-ground drain, originating in a small grating fixed in the centre of each stall, and communicating with an external reservoir or cistern, is found the most ready and beneficial method of insuring the removal of the urine from the stable. This method saves the litter by keeping the floor of the bed constantly drained, it decreases the general dampness of the stable, and adds to the health and comfort of the inmates. In many of the cart-horse stables in London, a central iron grating is placed over a small cesspool, but no longitudinal subterranean conduit is constructed to convey the fluid away; consequently, when it is full, the grating has to be removed and the contents baled out. This is a very objectionable practice; for though the stalls and litter may be kept dry, yet these collecting cesspools are so many reservoirs of fermenting fluids, increasing the chemical decomposition, and poisoning the atmosphere of the stable with ammoniacal vapour. It is far preferable to have a continuous underground drain, from stall to stall, throughout the stable, terminating in a sunken external reservoir, so constructed as to preclude the indraught of air up through the drains. Another advantage is attached to this manner of drainage; for as the fluid drains from the centre, there is no longer any necessity for that declivity of the flooring, which was requisite when the liquid passed away by the foot of the stall, for the ends and sides of the pavement of the stall may be of the same level, gradually bevelling towards the centre point where the grating is fixed."

The size of stables must be proportioned to the number of horses to be accommodated; but that of each, even when the number of horses is great, ought not to contain accommodation for more than five or six. Some horses will not sleep or even lie down unless perfectly at their ease; and when too many are in one stable, they are liable to disturb one another, and to be annoyed by the frequent entrance of persons in charge of them, and to suffer excessive contamination and heating of the air, so that they may have difficulty in going to rest, and cannot enjoy the most refreshing repose. The livery stables attached to many large inns in towns often exemplify the evils of disturbance consequent on too large capacity. The ceiling or roof ought, in every case, to be high, so as to allow a free ascent of the heated and contaminated air; and, in general, walls eight feet high, with the space above open to the roof, are preferable to even higher walls with a close ceiling. Double-headed stalls are objectionable, both on account of their allowing the stables to be crowded, and because the horses in them may hurt each other by kicking and collision. The size of stalls must correspond in some measure to the description of the horses kept in them; but, in every instance, ought to be wide enough to allow them to turn round without injuring themselves, and yet not so wide as to allow them to stand across; and, for each working farm horse, may be 6 feet or at the least 5½. The width of the stable from wall to wall ought to be such as to afford not only quite clear space for all the proper accommodations, but also a space of several feet behind the horses for the passing and working of the grooms. The floor should consist of granite causeway, hard brick, Dutch clinker, wooden blocks, patent elastic caoutchouc pavement, or of some other material which will firmly maintain a general level, and resist abrasion from pawing, and not subside into chinks or depressions.

When a hay-loft exists over a stable, it ought to be high and separated by so impermeable a flooring or ceiling as will completely prevent the escape into it of effluvia from below; but a hay-loft over a stable, no matter how well constructed, is, in all circumstances, exceedingly undesirable, both for sake of the sweetness of the hay and of the ventilation of the stable. "The rack and manger have long been regarded as essential structures in the fitting up of stables, and are still very generally employed; but when the better and more economical plan of cutting the fodder is adopted, the rack will become unnecessary. Upright racks are to be preferred to those inclining forwards, as, in the latter case, the horses are often much annoyed by the small seeds falling into their eyes and ears in drawing out the hay. Racks and mangers are very frequently constructed of cast-iron, and these are found much more durable and economical than those formed of wood. Under each window may be a recess for holding an oil-can, or vessel with tar; and, if provided with a door, it may be used for holding the combs and brushes which are employed in cleaning the horses. Every part of the harness in daily use should be placed behind the horse to whom it belongs, in order that no time may be lost in taking it off and putting it on; and that which is used only occasionally is to be kept in a separate lock-up apartment. There should be one or more lanterns suspended by cords and pulleys over the passage, for putting lighted candles in while feeding and cleaning

the horses during the winter. The loft being condemned in farm stables, a place must be provided for holding the food and litter; the most convenient will be one or two divisions opposite the door, into which the food, whether green clover or tares in summer or hay or roots in winter, can be readily carried from without, and easily distributed within. Being near the door, the food will be better ventilated than it could be in any other part of the stable, and it will occupy the least valuable part with reference to the horses; it being well known that the horse that stands opposite to the door is more liable to take cold than any other. The corn-bin or chest may also be kept in one of these divisions, and it ought to be large enough to have separate apartments for corn and beans, and for cut straw or hay, or bruised furze, to mix with the corn or pulse. The door-ways should be 4 feet wide and 7 feet high; and the door must not have any projecting latches or handles, because they are apt to hurt the horses, or become entangled with the harness in passing out and in." [Sproule's Treatise on Agriculture.]

A good degree of light in a stable, though not so much as to be glaring, promotes the comfort of horses, acts as a preservative of their sight, and prompts their keepers to maintain cleanliness and ventilation. Where little light is admitted, the walls should be frequently whitewashed; and where too much or even a moderate degree is admitted, they should be painted grey. One or more windows should exist in every farm-stable, according to the size; and each should consist of two sashes, moving up and down by pulleys, or sliding past each other in grooves, and should be glazed with small panes in leaden divisions, and protected by a luffer-boarding, with the laths placed in a horizontal position.

The maintaining of purity of air in a stable, by means of cleanliness and ventilation, is essential to the health and vigour of horses. Scarcely one farm-stable in fifty is thoroughly cleaned out even once a-week; and the noxious effluvia from the accumulation of excrements, litter, and frequently green food of various kinds, in different stages of decomposition, constantly exercise a baneful influence on the blood of both the horses and their keepers. The purer the atmosphere in which any animal is kept, the more vigorously and the more healthily will every function of the different organs of the body be performed, and consequently the inhalation of air impregnated with the stench of vegetable matter in a state of putrefaction, by corrupting the blood with which it comes in contact, vitiates every secretion of the body, and in time, if it cause not actual disease, which is most probable, never fails, at all events, to produce languor and debility. The gases arising from the excrements of horses, too, act prejudicially upon the eyes,—a fact of which any person who will remain in a foul stable while it is being cleaned may practically assure himself. Every farmer ought personally to superintend the care of his horses, and to insist upon his stable being daily cleaned out; and this operation, if regularly performed, will in the end occasion far less trouble than when filth of every kind is allowed to accumulate for days. The breeder of valuable horses in general is considerably alive to the necessity of attention to his young stock, while the man who has only an occasional colt or filly leaves the goodness of it pretty much to chance; yet the principle of obtaining for every horse a due supply of fresh air, and of keeping him in an atmosphere unimpregnated with noxious vapours of any kind, is the same as far as regards the purposes of health, whether a horse be worth ten pounds or a hundred. During the act of respiration one of the component parts of atmospheric air becomes destroyed by coming in contact with the carbon of the blood; and hence the air that is expired from the lungs, if inhaled again without admixture with fresh air, is deficient in those particles which should effect the chemical change in the blood, so necessary to life. For this reason, as well as on account of not allowing the noxious gases to escape, air-tight or closely shut stables are highly injurious to horses; and yet the practice of stopping up every aperture at night and excluding the air is very generally adopted by great numbers of people, alike ignorant of the injury they thus inflict upon their horses, and of the mode in which their superabundant and ill-directed care operates prejudicially upon animal life. Many men, too, while endeavouring to put valuable horses in condition prior to offering them for sale, are in the habit of thus coddling them up, with a view to improve the appearance of the coat,—an advantage which is frequently gained only at the risk of exciting inflammatory disease, and always with the loss of some portion of that sprightliness of movement and general vivacity so indicative of health and vigour. Yet mere perviousness to the air from the looseness of the doors or the craziness of the walls is very far from affording sufficient ventilation; and occasional free admission of the air by leaving the doors or the windows some time open may make such sudden changes of temperature or establish such strong cold currents as will seriously expose the horses to colds and inflammations. Apertures for the egress of the foul gases should exist in the roof or on the top of the walls; and apertures for the ingress of fresh air should exist near the floor;—and both should be covered externally by a grating, and so contrived as to be capable of graduation.

The littering of stables ought to have reference to the repose of the horses' bodies during the night and to the protection of their feet from unequal pressure on the floor during the day; and therefore it ought in all stables to be more or less removed every morning,—in stables with

perfectly sound and even floors, wholly removed, —and in stables with cobble-paved floors, allowed to remain just in sufficient quantity to protect the feet. "If retained," remarks Mr. Winter, "it prevents the quick and perfect drainage of the stall; it heats the feet and legs, causing a rapid wiring-in of the heels, contraction, thrushes, cracked heels, and swelled legs. A bed in the daytime entices the animal to lie down too much, and often provokes foul feeding. Some of our cavalry stables are a disgrace as well as a loss to the country. At the dictate of the commanding officer, who possibly likes to see the horses 'comfortable,' they are kept constantly bedded up to their knees: the result is, that there is scarcely a horse fit for actual service in the regiment. If attempts were made purposely to produce disease of the extremities, none could be found more destructively efficient than this baneful practice. Many of the evils which are falsely attributed to concussion, hard roads, bad shoeing, &c., are the evident results of this unnatural manner of keeping the feet. Veterinarians who wish to act honourably by their employers, should be loud in their remonstrances against the continuation of this destructive stable custom. It is their duty to point out its injurious tendency. The most ancient writer on cavalry affairs extant, Xenophon, is specific on this point. He says, 'It is good to enjoin the groom to carry out to one place, every day, the dung and straw from under the horse. When he does this, he will remove it with the greatest ease, and, at the same time, do a benefit to the horse.' The Arab litters his khayle with a shallow bed of dry horse-dung, which is daily removed and exposed to the sun: a similar practice obtains throughout Persia. In Egypt the floor of the stable is covered with fine desert sand, which is repeatedly changed, and never allowed to be saturated with moisture; and in no country in the world are the feet and legs of horses more free from disease." The rapid removal of ammoniacal vapours may be greatly aided by strewing gypsum on the floor, or by placing a thin layer of charcoal slightly moistened with sulphuric acid on a board or slab in some part inaccessible to the horses; and when the substance thus used becomes saturated with ammonia, it is a rich manure, and may either be employed alone as a dressing for almost any crop, or mixed with guano. The temperature of every stable should be regulated by means of the ventilators, and ascertained by means of a thermometer, and kept at about 55° in winter and between 60° and 65° in summer.

Every stable ought to be so framed, as to be convertible in a few minutes into loose boxes, and as easily reconvertible into its proper character; and this may be effected principally by the simple contrivance of having every alternate partition moveable. Or, at all events, two stalls in every stable ought to be convertible into a loose box by the removal of the intermediate partition. The occasional placing of horses in loose boxes instead of stalls serves some eminently useful purposes in ordinary stable management, and is a powerful therapeutic measure in all cases of injury from over-exertion, and in many kinds of the most ordinary diseases; and it is not only becoming more general than formerly in all sorts of well-managed establishments, but is even regarded as essential to the economy and the good conduct of every stable of proper character. "It would be well," remarks Delabere Blaine, "were in-door horses more generally accustomed to spend their leisure time in boxes than stalls. Boxes are advantageous to the jaded horse, by encouraging him to lie down during the day; they are advantageous to the idle horse, by encouraging him to exercise himself. By means of boxes, the evils of long frosts to the hunter are avoided, and the unrestrained enjoyment of freedom is relished by all. A loose box wholly unconnected with the stable is also a valuable appendage to a gentleman's establishment,—it may thus with impunity be the receptacle of a contagious case. The detached box should be so constructed as to be capable of being cooled to nearly the temperature of the external air, or, when necessary, to be made as warm as requisite for some cases of sickness. No projections should be allowed in its walls to hurt the hips in cases of falling from weakness, staggers, &c. It should, also, have a grate in the centre communicating with an outer cesspool, with a general slight leaning of the flooring to the grating. Into a large box of this description every horse taken up from grass should be first put, to prevent the access of the worst colds to which horses are liable, which are those caught on the sudden removal from a cool into a heated temperature."

STACHYS. See HEDGE-NETTLE.

STACHYTARPHETA. A genus of ornamental, exotic plants, of the verbena family. Nearly a dozen species have been introduced to British gardens from Ceylon, Cayenne, the West Indies, and South America; and several more are known. The introduced species comprise annuals, biennials, herbaceous perennials, and evergreen shrubs; they vary in height from 12 to 40 inches; three carry respectively white, orange, and violet flowers, and all the rest carry blue flowers; and most bloom in summer, and love a soil of peaty loam. The popular name of some of the earliest known kinds is bastard vervain.

STACK. A large pile of sheaf-corn, hay, turf, or other matter built and thatched for protection from the weather. But piles of hay are more properly called ricks, and piles of turf more properly turf-stacks; and piles of sheaf-corn formed at the time of harvesting, and generally situated in the yard immediately adjacent to the barn, are the chief and truest stacks. These vary in form and size according to the usages of dis-

tricts, the taste of farmers, the extent of crops, and the circumstances of farms. Long, narrow, quadrangular stacks are preferred, in some instances, for convenience of erection, firmness of structure, pleasantness of appearance, and economy of thatching; but circular stacks, of 12 feet or upwards in diameter, with either a cylindrical or a gradually widening body, and with a roof or head in the form of a cone, are found, in the aggregate of enlightened experience, to comprise the greatest amount of advantages.

The old stool or foundation used for a stack was either a quantity of loose dry straw, laid on dry ground or bedded on brushwood, or a compact layer of dry boulders or other large stones; but that now in use, in all well-managed farms, is a stand, staddle, frame, or platform, of the same diameter and periphery as the stack, supported on feet or short pillars of either wood, stone, or iron; and this serves the three-fold purpose of preserving the stack from the depredations of rats and mice, of protecting it from the moisture of the ground, and of admitting the air from below to circulate through its body and to maintain it in sweet and sound condition. In beginning to form a circular stack, a sheaf is placed upright on its butt end, as nearly as possible in the centre of the stool; and around this other sheaves are placed in circles, likewise upright, but with a small inclination of their tops inwards. Circular ranges of these upright sheaves are continued till nearly the whole stool is occupied. The stacker then begins to place his outside row of sheaves, bending them by means of his knees, so that their butts become somewhat horizontal from the band downwards, while their heads lean obliquely upwards and inwards against the outer range of the upright sheaves. He continues to lay on circular layers of sheaves, their butts all outwards, till he has raised the outside of the stack nearly to a level with the tops of the original upright sheaves, which are now all forced into great obliquity inwards, and into considerable consolidation. He then fills up the heart of the stack; in doing which, he does not place the sheaves in any very exact order, yet so arranges all as to fill up the space equably, the centre or heart being always highest, and the corn ends of the sheaves inwards, every sheaf or row of sheaves having a regular and obvious slope downwards and outwards towards their butts. The stacker never steps upon the central part of the stack; and, in consequence, that part is always left comparatively open, or less compressed than the exterior of the stack,—all the sheaves of which are pressed down by his weight. He now forms a circular row of sheaves about 15 or 18 inches within the outside circle; and this is very carefully laid sloping outwards and downwards at its butts, and upwards at the ear-ends, which rest or ride upon the heart of the stack. After this he again fills up the heart. He next lays a new outside circular row, the ear-ends of which are obliquely elevated by the butts of the former inner row; and he continues to lay alternately outside rows, heart rows, and heartings, always carefully preserving a considerable central elevation, by which all the butts in the whole composition of the stack have an obliquity outwards and downwards. In forming very large stacks, or when the straw is very short, there may be two or even three or more series of heart-rows, overlapping each other as already described, and all carefully constructed under the proper precautions, by which the penetration of rain into the stacks is effectually prevented. In the formation of all the circular rows, the stacker works upon his knees, pressing down every successive sheaf into its place by the application of his weight; and to ensure regular equality in building, he always begins a new circular row at a different place from where the former terminated. When he has carried up his stack to the intended height, perhaps 10, 12, or 15 feet, he sets what in Scotland is called 'the easing gang,' or an outside circular row of sheaves, having the butts projecting a few inches beyond the body of the stack, and forming the eaves. After this, every successive row of outside sheaves is placed gradually more inwards, and the heart of the stack is always most carefully preserved higher than the outside row, and even a good deal more so in the head of the stack than while building the body, continuing or rather increasing the obliquity of the sheaves. When he has drawn the roof of the stack to a narrow circle or platform of 3 or 4 feet in diameter, he quits the kneeling posture in which he had hitherto worked, and places one sheaf upright in the centre of the small platform, filling the whole of that space with upright sheaves set around the centre one, and leaning a little towards it. He then gets a straw-rope, with the middle of which he firmly embraces these upright sheaves, by two or three turns of the rope, and the assistants fasten the two ends of that rope on opposite sides of the stack, so as to secure this conical crown of sheaves from being thrown over by the wind. A stack carefully built in this manner, and afterwards properly thatched, will bid defiance to any kind of weather, except a hurricane; and can even be very little injured by rain coming on before it is thatched; and no good farmer, unless from necessity, trusts his stack even for a day or two without thatching.

The best straw for thatching is that of rye, and the next best is wheat-straw; but, in defect of both, the straw of barley or oats must be employed. The straw must all be previously drawn, the short straws shaken out, the long straw laid parallel and bound up into sheaves, and the short straw made into bunches. In laying on the thatch, the thatcher stands upon the sloping conical roof of the rick, as near as he can to the eaves, and lays on the straw in handfuls, from sheaves placed within his reach. He thrusts the

inner end of his handful of thatch, gathered into a neck or wisp, into the butts of the sheaves, and spreads out the lower end like a fan, overhanging the eaves. Beginning at the eaves, and covering as much of these as he can reach at arm's length, he works upwards, causing each successive handful to overlap that immediately below; and he thus covers the roof in triangular portions, till he has gone round the whole backwards, that he may avoid treading on his work. When he has reached the top of all, he lays a considerable thickness of short straw upon the crown, over which a straw-rope is carried perpendicularly, dividing the roof into two equal sections. He then covers this topping of short straw with long thatch, drawn to a point at the summit, and ties the upper ends of this with a small straw-rope into a peak, giving this last part the resemblance of an umbrella. With the aid of two assistants on the ground, while he remains aloft on a ladder, so as to be able nearly to reach the top of all with his hands, the thatcher now places a number of straw-ropes, which obliquely embrace the conical roof, to secure the thatch. The middle of each rope is fixed, by means of a small wisp of straw, to the perpendicularly transverse rope already mentioned, and the ends of all the oblique ropes are fixed below by the assistants, either to the butts of the sheaves in the cylindrical body of the stack, or to a circular belt rope which firmly embraces the body below the eaves. If this is too high for the assistants, each has a short ladder to enable him to reach up. This series of ropes has a considerable obliquity from above downwards, and they are placed at about a foot or 15 inches distant from each other. In case of hurry from the prospect of bad weather, this first series of oblique ropes may secure the thatch from being blown off for some time; and in such emergencies, all the stacks belonging to a farm may be left for a time in this state. The whole fabric is effectually secured by a similar and opposite series of straw-ropes, put in the same manner on the other side of the roof, and obliquely crossing the first series of ropes. When thus finished, the entire roof is covered by a network of lozenge-shaped meshes, all the sides of every one of which are in a direction obliquely downwards, to facilitate the descent of moisture, either from rain or melting snow. A contrivance for promoting ventilation through the centre of a stack is noticed in the article Boss.

An oblong stack may be built with interruptions at regular intervals, for the convenience of taking it down in parts without disturbance to the remainder; and it is roofed in a ridge-form like a house, and is thatched similarly to a circular stack, but with the straw ropes stretched directly across. A main and very important objection to it, showing its vast inferiority to a circular stack, is its obstruction of the free circulation of the air, and its special liability to injury from the moisture of wet weather. The practice which prevails in some English districts of storing sheaf-corn wholly or principally in barns, is both inconvenient and very expensive. See the article Barn.

STACKHOUSIA. A small genus of exotic, monochlamydeous plants, constituting the type of the small natural order Stackhouseæ. Only two or three species have as yet been introduced to Britain; and all are from Australia, and but slightly ornamental. The flax-leaved stackhousia is an evergreen shrub of about two feet in height; and the one-styled is an evergreen shrub, of about one foot in height, carrying light pinkish flowers in April.

STACKYARD. See Farm-Buildings and Barn.

STADDLE. See Stack and Haymaking.

STÆHELINA. A genus of ornamental exotic plants, of the thistle division of the composite order. Its plants possess considerable affinity to the helichrysums and the finer kinds of gnaphaliums, and used formerly to be called wild immortal flowers. The doubtful species, *S. dubia*, is a hardy, deciduous, fragrant, purple-flowered shrub, about 3 feet high, blooming in June and July, loving a soil of peaty loam, and propagable from cuttings; and was introduced about two centuries ago from the south of Europe. Two frame, purple-flowered, evergreen shrubs have been introduced from Crete; and nearly a dozen other species are known.

STAFF-TREE. See Celastrus.

STAG. See Deer.

STAG-EVIL. See Tetanus.

STAGGERS. Several analogous yet widely different diseases of the chief domesticated animals. All are violent, and take their name from a staggering gait in their subjects, and require great promptitude and skill of treatment. The mad staggers of horses is phrenitis, and has been noticed in the article Inflammation. A similar staggers to this sometimes occurs in sheep and hogs, and ought to be similarly treated. The common staggers of sheep and oxen arises from the presence of a peculiar entozoon in the head, and has been noticed in the article Hydatid.

The stomach staggers or symptomatic staggers of horses arises from distention of the stomach with dry undigested food, producing pressure on the brain, and sometimes exciting inflammation in the intestines and the lungs. A horse affected with it hangs down his head, or rests it in the manger, appears drowsy, and refuses his food. His tongue and mouth are tinged of a yellowish colour; and commonly the membrane under his eyelid is more deeply tinged, and approaches in general to a dusky orange colour. A slight convulsive or twitching motion occurs in the muscles of the chest; the forelegs appear suddenly to give way at times, as if the horse would fall; and he rarely lies down, unless the disease is going off or death is approaching. The pulse is never affected in the early stage of this complaint, but sometimes begins to indicate by and

bye the commencement of inflammation. The disease is always attended with costiveness; and the dung that is drawn off by raking is generally hard and slimy. The urine is generally in small quantity; and in the latter stage of the disease, the jaw sometimes becomes locked. Stomach staggers never appears to originate in contagion or infection. When it occurs at grass it is generally about autumn, and frequently in meadows adjoining rivers, and other situations where the herbage is rank and innutritious; and when it occurs in stables, its seems to arise from the horse's eating too greedily, swallowing his food when imperfectly chewed, or eating freely of food that is difficult of digestion. Young vigorous horses may digest the most unwholesome food; but such as have been debilitated by hard usage, and are rather advanced in age, become very weak in their digestive organs, and when improperly fed are liable to stomach staggers. One of the best remedies is a mixture of a powerful stimulant with a purgative, such as a ball consisting of three drachms of calomel, two drachms of carbonate of ammonia, three drachms of ginger, six drachms of aloes, and a sufficient quantity of syrup. The hard fæces should be drawn from the rectum, and opening glysters injected. Some stimulating fluid, such as warm salt water with a little mustard or compound spirit of ammonia, should be given after the ball, and frequently repeated. When the fæces become soft, and the horse appears to be getting better, a drink of oatmeal gruel or of wheat-flour gruel may frequently be given to him, and a little cordial medicine may also be allowed; but, for a few days after his recovery, he must be fed with care, and not allowed any hay. One of the most effectual preventives of stomach staggers, is the plan now commonly adopted by brewers' servants, stage-waggoners, and all ordinary carters, of feeding with hay on the road, or carrying with them nose-bags.

Common or proper or idiopathic staggers in the horse is apoplexy, but is confounded sometimes with stomach staggers, and very generally with phrenitis; and it considerably resembles the latter disease in at once causes, symptoms, and cure. It commonly begins with an appearance of drowsiness, the eyes being inflamed and full of tears, and the appetite diminished. The disposition to sleep gradually increases; and in a short time the horse is constantly resting his head in the manger and sleeping. The pulse is seldom much altered; but, as in stomach staggers, costiveness and a defective secretion of urine are commonly present. Sometimes the disease will continue in this state for several days; at others, it assumes a formidable appearance very early, or even at its commencement, the horse falling down, and lying in a state of insensibility, or becoming violently convulsed. Sometimes a furious delirium takes place, the horse plunging or throwing himself about the stable, so as to render it dangerous for any one to come near him. The first stage of the complaint arises from an accumulation of blood in the vessels of the brain, which impedes in some degree the functions of that important organ; and if these vessels are not relieved by copious bleeding, there will be either an effusion of water in its ventricles, an inflammation of the membranes, or a rupture of some blood-vessel, and consequently an extravasation of blood. But sometimes there is so sudden a determination of blood to the brain, that these dangerous symptoms make their appearance before an effectual remedy can be applied. Bleeding is the grand remedy, and seldom fails of affording relief if employed with freedom at the commencement of the disease. It will be advisable also to give a purgative draft, and inject a stimulating glyster. If the symptoms do not abate in 8 or 10 hours after the bleeding, there will be great probability of obtaining relief by opening the temporal arteries, and suffering them to bleed freely; and if the disposition to sleep is not removed by the first bleeding, the head should be blistered, and a rowel inserted under the jaw.

Apoplectic staggers of cattle, sheep, and hogs, is closely similar to apoplexy of horses; but usually occurs when the animals are in a highly fed and plethoric condition. In the case of cattle, it is often called popularly blood-striking; and in the case of sheep, it is often popularly called blood. In both cattle and hogs, the premonitory or early symptoms are generally so slight as to escape observation, and the apparent commencement of the disease is both very sudden and exceedingly violent; and in all animals whatever, just as in the horse, the grand remedies are prompt and copious bleeding, and judiciously conducted purging. In the case of cattle, Youatt says, "If there is time to do anything, the beast should be bled, and as much blood should be taken away as can be got. A pound and a half of Epsom salts should next be given, and without any carminative; and this followed up with doses of half a pound until the physic operates; its action should afterwards be maintained by six-ounce doses of sulphur every morning. The congestion of blood in the vessels of the brain being removed, and also the congestion which, to a certain degree, prevails everywhere, the beast should be slaughtered; for he is liable to a return of the complaint from causes which would not, previous to his first attack, have in the slightest degree affected him." In the case of sheep, Mr. Cleeve says, "This disease generally occurs when on the road to market. The sheep are then in high condition, and often overdriven beneath a sultry sun. The drover should carefully watch any sheep that lags behind. If it appears stupid and unconscious, heedless of the dog and forgetful of its companions, it should be instantly and copiously bleed from the neck. A prompt flow of blood is indispensable in this case. Every surgeon knows that the loss of the same quantity of

blood taken away in three minutes will have much greater effect than will be produced if it is allowed to dribble away in twice the time. If the sheep is on the road to the butcher, nothing further is necessary; but, should it be attacked at home, the shepherd must change its pasture, and keep the bowels freely open by repeated doses of Epsom salts."

STAGNANT-WATER. Water which has accumulated on land from rain or snow or drainage, and which cannot find a vent, but lies on the surface till it is dissipated by evaporation. It always contains more or less of dead and decomposing organic matter, which has been washed or absorbed into it in the course of its accumulation; and, in some instances, it is so full of this as to emit very offensive effluvia, and send off gases of highly noxious action on the health of man and of all domesticated animals. The nature and effects of it on bogs, marshes, and retentive arable lands are noticed in the articles Bog, Marsh, and Draining. Ponds of it in the vicinity of human dwellings, especially in situations which catch the drainings of yards or of dunghills, are exceedingly pestiferous, and ought never to be allowed. Some kinds of it, particularly steeps of flax and hemp, fetid ponds, farm-yard drainings, and foul ditches, are very fertilizing, and may be usefully employed in saturating dung-heaps, and making earthy composts.

STAKE. An upright piece of wood, fastened in the ground.

STALING. See Urine, Redwater, and Diabetes.

STALK. A stem of a plant.

STALL. The compartment for a horse in a stable, for a cow in a cow-house, or for an ox in a feeding-house. See the articles Stable, Cow-House, and Ox-Stalls.

STALL-FEEDING. The confining of cattle wholly to stalls during the processes of ulterior feeding and of fattening. The peculiar advantages of it, additional to those of soiling, consist in keeping the animals quiet, in nicely adapting their food to their circumstances, and in accelerating the grand result of fitness for the market. See the articles Soiling, Feeding of Animals, and Fattening of Animals.

STALLION. See Horse.

STAMENS. The fecundating organs of plants. They perform functions which Linnæus fancied to be analogous to those of males in animals, and were therefore treated by him as chief characters in framing his artificial system of botany. See the article Botany. They are always present in flowers, as well in those which have no corolla as in those which have; and when a corolla is present, they are always situated immediately within it, and generally alternate with its segments. Each consists of a filament and an anther; and produces in the latter the fecundating dust. See the articles Anther and Pollen. Those of the same flower sometimes cohere by the filaments,—and, if in one set, are called monadelphous,—if in two sets, diadelphous,—and if in more than two sets, polyadelphous. They sometimes also, as in the nineteenth class of the Linnæan system, cohere by the anthers; and they are then said to be syngenesious.

STAMWOOD. The grubbed up roots of felled trees.

STANDARD. A young tree reserved at the felling of a wood; also, a fruit-tree growing in an open exposure, or apart from any wall or trellis, and allowed to assume its natural shape instead of being contorted by pruning and training. A young standard fruit-tree, in general, should not exceed two years from the bud or graft when it is planted, and should be fortified by a stake till it acquire sufficient strength to make a firm resistance to the strongest wind by which it is likely to be assailed.

STANHOPEA. A genus of ornamental, tropical, epiphytous plants, of the orchis family. It is one of the most natural and interesting of the orchidaceous genera; it has one leaf to each pseudo-bulb, and sends out the flowers from the bulb's base; and it comprises a number of species of great beauty and brilliance.

All the species require to become firmly rooted, and must therefore be grown in peaty soil of the most fibrous nature, so that no water may lodge about the roots to cause any of the radicles to rot; and, whenever fine specimens are desired, they must be placed either in pots with an elevation of about a foot above the rim or in large baskets,—for all push their flowers downwards, and cannot possibly make a good show unless placed either high above the pots or in sufficiently capacious and open baskets. Every pot should be filled with large potsherds to within about two inches of the top; the mound above its rim should be built as nearly as possible of the same width as the pot; the heathy portion of the peat should be laid immediately over the potsherds; and the rest of the peat may be either cut or torn into small portions for building the mound, and may be fastened on with a few pegs. Every basket should be formed of oak billets, each about one inch in diameter, and should be open all round and below with distances of two inches between the bars, and should have a depth of about three inches. The plants must be kept in the same pots or baskets without shifting for several years; and, whenever a shift becomes necessary, they must be removed and repotted in the growing season, about the end of July or beginning of August. Most of them, as soon as they have done flowering, commence growing; and from the time of their beginning to show signs of growth till they complete their pseudo-bulbs, they should have great heat and abundant moisture; and then they should be taken out of the moist house and kept in the dry one till they show flower, when they must be taken back to the moist house, and receive

little or no water till they begin to grow. The air in the moist house should be kept up to near the point of saturation, and will be rather injured than benefited by the free or frequent admission of fresh air from without.

The large-flowered stanhopea, *S. grandiflora*, was the earliest introduced into Britain; and is a native of the trees of Brazil. It grows and flowers at the same time, and requires less rest than any of the other species; so that it may be always kept in the moist house. Its flowers are white, and have a peculiar odour, not unlike that of rhubarb. — The ivory-lipped stanhopea, *S. eburnea*, is only a variety of the large-flowered, and not a very marked one.—The graceful stanhopea, *S. venusta*, is a beautiful and very distinct species, and a native of Mexico. Its flowers are similar in form to those of the large-flowered, and also emit a strong odour like that of rhubarb, but have a yellow colour. This species requires a good rest after it has done growing.—The four-horned stanhopea, *S. quadricornis*, is a well marked species, having four horns on the lip. It is not so rich in colour as some of the others, but has a more delicate scent than many. It flowers earlier than either of the former, and of course grows sooner.—The bagged stanhopea, *S. saccata*, is a most interesting species, a native of Mexico, having a large bag at the base of the lip. It has an orange lip with straw coloured vessels, and petals beautifully covered with dark spots. It flowers in May and June, and sometimes later. —Ward's stanhopea, *S. Wardii*, is a very handsome species. It has flowers of a pale yellow, beautifully spotted, and is well worthy of the cultivator's attention. It flowers in June and July, and very seldom begins to grow before August. The number of flowers on a spike is from five to twelve.—The tiger-marked stanhopea, *S. tigrini*, is the most splendid and singularly formed species of all the genus. The lip is dark and of a very fleshy texture; and the vessels and petals are of a pale colour, with large dark stripes. It flowers in June and July, and begins to grow in August; and it has from two to three flowers on a spike.—The Martian stanhopea, *S. Martiana*, is very nearly related to the tiger-marked.—The eyed stanhopea, *S. oculata*, is a pleasing and very interesting species. The lower portion of the lip has a yellow cast, and has a dark spot resembling an eye; and the upper portion is like white ivory, and beautifully spotted with purple. The vessels and petals are of a pale straw colour, finely spotted with dark purple.—The Devonshire stanhopea, *S. Devoniensis*, is a very splendid species, somewhat like the tiger-marked, but not so large, and has a very differently formed lip, and the vessels and petals of a much darker colour. It comes into flower in June and July.—The remarkable stanhopea, *S. insignis*, is another beautiful species. The vessels and petals are pale yellow, with purple spots; and the lip is very curiously formed, and of a thick and fleshy nature.

STANLEYA. A small genus of ornamental exotic plants, of the cruciferous order. The pinnatifid species, *S. pinnatifida*, is a frame, perennial rooted herb, of about a foot in height, carrying yellow flowers in June and July; and was introduced to Britain about 30 years ago from Louisiana; and is propagated from seeds.

STAPELIA. A genus of curious, Cape-of-Good-Hope, evergreen undershrubs, of the swallow-wort family. A number of species which formerly belonged to it are now distributed among twelve other genera; but nearly forty, still belonging to it, occur in British collections. Their stems are short and fleshy, and supply the place of leaves, and vary in height from 3 to 25 inches; and their flowers have a remarkable complex organization, and are distinguished by strange colouring and spotting, and emit an offensive fetor, and, in a number of instances, bloom in autumn or in winter. All love a soil of sandy loam, and are propagated from cuttings.

STAPHISAGRIA. See Larkspur.

STAPHYLEA. See Bladder-Nut.

STAR-APPLE, — botanically *Chrysophyllum*. A genus of tropical, evergreen, ornamental fruit-trees, of the sapota tribe. Six species, varying in natural height from 15 to 100 feet, and all, with one exception, carrying white-coloured flowers, have been introduced to Britain, principally from the West Indies and tropical America; and nine more are known. The leaves are deep green above, and shine like satin below, and cause the plants to have a fine appearance in the stove throughout the year; the fruit is at first rough and astringent, but becomes mellow with age and keeping, and is much relished in the native countries of the plants; and the timber of the larger species is used in carpentry and for shingles to cover houses. All the introduced species love a soil of rich mould, and are propagated from cuttings. The best known of them, comprising several varieties, is noticed in the article Cainito.

STARCH. A well known and very abundant proximate principle of plants. It constitutes a large portion of esculent seeds, and is very common in fleshy roots, and abounds in the pith of some ligneous stems, and occurs in the cellular tissue of even such plants as burdock, buttercup, dropwort, deadly night-shade, white bryony, bistort, and henbane. It passes into sugar during the germination of seeds, and plays an important part in the chemistry of all the subsequent growth of plants, and forms a bulky and important ingredient in the ripened state of their esculent products for the nutrition of man and of the lower animals. In a separate and manufactured state, also, it is nearly identical with arrow-root, cassava, and salep, and constitutes the chief bulk of sago, tapioca, farina, sowens, and potato tubers. See the articles Nutrition, Germination, Seed, Alimentary Principles, Amy-

LINE, ARROW-ROOT, CASSAVA, ORCHIS, SAGO, FARINA, OATMEAL, and POTATO.

"Starch," says Boussingault, "is contained in the cells of vegetables under the form of small white granules which have no crystalline structure. In the year 1716, Leuwenhoeck ascertained that these granules were globular bodies more or less regular in their contours. He believed that he could perceive each globule enclosed in an envelope, a kind of sac, different in its nature from the matter which it contained. M. Raspail, a few years ago, confirmed by his own researches the observations of Leuwenhoeck; he further attempted to measure the diameter of the globules in different kinds of starch, and came to the conclusion that their capsule is insoluble, and that it is the internal part alone which is soluble in hot water. Since then MM. Payen and Persoz have ascertained that if the globules of starch be really surrounded by a capsule, it must be present in a quantity scarcely appreciable,—a quantity not exceeding $\frac{1}{4000}$th of the weight of the starch. These first researches were followed by the subsequent observations of M. Payen, who has devoted himself to the study of the amylaceous principle with a zeal and perseverance which must secure him the gratitude of chemists and physiologists. M. Payen has examined a vast number of feculæ microscopically; the largest granules he observed were obtained from one of the varieties of potato, from the *Menispermum palmatum*, and the *Canna gigantea*. The globules of starch frequently exhibit a polyhedral appearance, a figure which evidently results from their mutual pressure as they have lain in the cells of the vegetable. Notwithstanding a great general analogy of form, the granules of the starch of different species of vegetables, still present peculiar physiognomies, so that they can be distinguished in many instances by the practised eye. A character common to the majority of feculæ, however, is roundness of contour, when their particles have not been compressed by their contact in contiguous cells. Microscopical and chemical researches alike show that starch is homogeneous in properties, as in composition; that its globules are composed of concentric layers, the external of which have exactly the same characters as the internal layers.

"In the natural state, starch is insoluble in water and in alcohol; it is very ductile; and under the influence of certain agents, it exhibits a great degree of contractility. Feculas retain water with considerable force; the quantity retained varies with the temperature at which the drying was accomplished. Thus the fecula of the potato, which is moist and porous, even when subjected to strong pressure, still retains 45 per cent. of water. This is the green or raw starch of manufacturers. Dry starch is very hygrometric. If after being dried it is placed in an atmosphere saturated with moisture, at 20° centig. (68° Fahr.) it will absorb nearly 36 per cent. of water, and its bulk increases in the ratio of one to one and a half; in this state starch is brilliantly white, and its grains adhere so closely that they form a mass of sufficient firmness to take the impress of a seal. Starch in this state, however, pressed upon paper yields no perceptible trace of moisture; it is too hard and adherent to pass through a sieve; and when thrown on a metal plate heated to 257° Fahr. its particles immediately unite and form a cake. The starch of commerce, in the state in which it is usually found in shops, contains 18 per cent. of water; it is either pulverulent or readily reducible to powder, though by slight pressure in the hand, it may be formed into a mass or ball. After drying in vacuo at the ordinary temperature, starch retains no more than 10 per cent. of moisture; a temperature not less than 284° Fahr. is required to dry it completely; the water which it retains at this temperature belongs to its constitution, and cannot be taken from it except by combining it with bases. MM. Collin and Gaultier de Claubry discovered the important character of starch, that of yielding a fine blue or violet colour on combining with iodine. According to M. Payen, the colour is more intense, nearer to blue and more lasting, in proportion as the starch is more strongly compressed; the effect of separation is to turn the blue to shades of violet which approach redness as the substance is looser. The same fecula, according to the degree of its aggregation in plants, is seen to assume shades, which are first reddish, then violet, and eventually of a more decided blue colour, under the action of iodine. M. Lassaigne has noticed a very curious property of the combination of iodine and starch; if an amylaceous fluid, having the decided blue colour, be heated to 193° or 194° Fahr., the solution becomes completely blanched; but it resumes its former tint as the liquid cools. This property, which starch possesses of striking a blue colour with iodine, renders one of these bodies an excellent test for the other. However, as the iodine must exist in the free state to produce its effect, it is necessary, when the blue colour does not show itself at once, in a solution in which iodine is suspected, and to which starch has been added, to add a few drops of sulphuric acid, so as to decompose the hydriodic acid in cases where it may exist.

"It is familiarly known that, if raw starch be mixed with boiling water, the result will be a thick, paste-made starch. According to M. Payen, the change that takes place in the state of the fecula is owing to a swelling, a rupture, or disgregation of its granules. By heating a drachm of starch, mixed with about a couple of ounces of water to about 140° Fahr., the microscope shows us that the smallest or youngest grains,—those possessed of the least cohesion,—have absorbed a considerable quantity of water, and that the expansion of the contents has caused a certain num-

ber of the globules to burst. At this temperature, however, some grains of fecula are observed, which do not appear to have yet attained their maximum of enlargement, and whose contents consequently are not yet diffused through the liquid. It is only between 161·6° and 212° Fahr. that the maximum of expansion becomes general and that the solution acquires its greatest consistency. The remarkable property possessed by starch of making a glutinous solution or thick paste with water under the influence of heat, led M. Payen to conjecture that a contrary effect would be produced by lowering the temperature,—that the starch might be recovered in its original state of distinct globules by suitable management; and this he in fact accomplished by an ingenious procedure. Starch appears to suffer no actual change when diffused in water by exposure to a temperature of 212° Fahr.; the granules have only swollen to about thirty times their original dimensions by the imbibition of a large quantity of water.

"Formerly, the starch of commerce was universally obtained from grain,—wheat; at present, the potato furnishes a still larger quantity than grain. In the equatorial regions of South America, starch is abundantly prepared from the *Jatropha manihot*, and from several species of palm. To obtain starch from wheat, the grain is either coarsely ground and mixed with water in large tubs, or it is put to steep in sacks until it is so soft that a process of kneading suffices to set the starch at liberty. To obtain it from potatoes, the tubers are grated after having been well washed, and the pulp being thrown on a sieve, the starch is carried off by the water and deposited in suitable vessels. The washings in the manufacture of potato starch soon become putrid by reason of the azotised matter which they contain, and until lately occasioned much annoyance, until M. Dailly conceived the happy idea of turning them to account as liquid manure. None of the amylaceous principles or feculas obtained by the ordinary processes are absolutely pure; even supposing all the soluble substances to have been removed by washing, they still retain fatty matters, azotised principles, and colouring substances. Starch is purified by following up the water washings by the action of alcohol, of acetic acid, and of ammonia. Starch in its state of greatest purity, and dried at 212° Fahr. contains, according to the analysis of M. Jacquelain, 44·9 per cent. of carbon, 6·3 of hydrogen, and 48·8 of oxygen.

"By slight roasting, amylaceous feculas undergo considerable changes; they become soluble in water, and then present the properties of gum. Starch thus roasted, supplies the place of gum in various manufacturing processes; still it should not be confounded with gum in a chemical point of view. The acids act with more or less energy on starch, and give rise to different products. Nitric acid, when it is diluted with water, merely dissolves fecula; but at a certain degree of concentration, it exerts a destructive action. In this reaction several acids are formed, among others oxalic acid. By employing very dilute sulphuric acid, Kirchhoff succeeded in changing starch into a saccharine substance similar to the sugar of the grape. The operation may be performed in a leaden or silver pan, or, what is preferable, especially when the process is carried on upon the great scale, in wooden vessels, in which the liquid mass is heated by steam. According to M. Couverchel, several organic acids are capable of changing fecula into sugar in a similar manner; such are oxalic, tartaric, and malic acids. The artificial conversion of starch into grape sugar has not yet been satisfactorily accounted for. The acid employed does not seem to undergo any change; it is found in its original state and quantity after the operation. M. de Saussure thinks that the effect of the reaction is the fixation of water; thus 100 parts of fecula yielded him 110·40 parts of sugar. M. Couverchel and M. Guérin, on the contrary, state that the quantity of sugar obtained was less than that of the starch they employed. Gluten exerts a reaction on starch similar to that produced by acids; Kirchhoff discovered, that under the influence of the azotised matters which are met with in flour, the fecula is converted into sugar. Two parts of starch being mixed with four parts of cold water, on adding twenty parts of boiling water, a thick paste is produced; if into this one part of dry, powdered gluten be introduced, and the mixture be kept at the temperature of 140° Fahr., the paste becomes more and more liquid, so that the mixture may be filtered at the end of from six to eight hours. By concentration a syrup is obtained, in which small crystals of sugar are perceived. It is well known that during the act of germination, fermentable saccharine matter is produced. Kirchhoff concluded from his experiments, that this production of sugar in germination is attributable to the reaction of the gluten on the starch. Germinating grain, barley-malt for instance, reacts rapidly and powerfully on any fecula with which it is brought into contact,—a fact well known to, and constantly taken advantage of, by manufacturers of spirits from potatoes and raw grain, large mashes of which are rapidly converted into sweet fermentable liquids under the action of a little malt. These facts, it is evident, cannot be explained by Kirchhoff's experiment; in the fermentation of the potato, the mass of fecula to be converted into sugar is too great compared with the quantity of gluten which exists in the malted barley. Further, the gluten in grain which has not germinated, scarcely exerts any appreciable action. The principle which, in the preceding operations, converts the starch into sugar must therefore become developed during germination. This important point in the art of the distiller has

been investigated with great ingenuity by M. Dubrunfaut; and MM. Persoz and Payen succeeded in separating the peculiar matter in barley malt which possesses the property of converting starch into sugar. This matter has been called diastase.

"Diastase exists in the seeds of all the cereals which have germinated; it is met with more especially near the germs, it seems even that the radicles contain none of it. Nor is diastase observed in the shoots or roots of the potato; it is to be met with only in the tubers, around the eyes or points where the young sprouts are developed, precisely as M. Payen has remarked, in the place where we should conceive its presence to be necessary for effecting the solution of the fecula. It is also found to exist in the bark and beneath the buds of trees, always in contact with starch. Diastase is generally obtained from malt; and when carefully prepared, its peculiar power is such, that one part by weight is sufficient completely to liquefy two thousand parts of starch. Diastase is solid, white, amorphous, insoluble in pure alcohol, soluble in water and weak alcohol. The solution very readily undergoes change; it becomes acid, and then no longer exerts any action on fecula. When dried, it keeps much better; still, at the end of two years, it seems to have lost its distinguishing properties. Diastase has no action on vegetable tinctures, on albumen, gluten, cane-sugar, gum-arabic, or the woody-fibre. That which more especially characterizes it, is its powerful action on fecula; it may be advantageously used to separate and purify the preceding substances, when they are mixed with starch. The presence of diastase in malt explains the phenomenon of the liquefaction of starch effected by the action of a small quantity of that substance. This solution is not effected by gluten, nor by hordein, as M. Dubrunfaut had imagined. By the action of diastase, or of malted barley, the starch on being liquefied is not entirely converted into sugar; there are other distinct products to be considered in this change. The syrup obtained by concentrating the liquefied starch, contains sugar capable of undergoing the vinous fermentation, and a gummy matter, dextrine. These two substances may be separated by means of dilute alcohol, which dissolves the sugar and leaves the gum untouched. The relative quantities of dextrine and sugar produced by the action of diastase are variable, and depend both on the temperature at which the process is conducted, and on the continuance of the reaction. In the first period of the process, the dextrine predominates; but it becomes less and less by degrees, and finally gives place to sugar. M. Guérin ascertained a curious fact, which shows how the diastase developed in plants may act on their starch: reaction takes place even at ordinary temperatures. In one of M. Guérin's experiments, at a temperature no higher than 68° Fahr., a quantity of starch, at the end of 24 hours, was converted into syrup, which yielded 77 per cent. of saccharine matter.

"M. Payen freed dextrine from the sugar which usually accompanies it by precipitating a syrup of fecula previously dissolved in dilute alcohol, by means of alcohol nearly free from water. Dextrine well dried, and reduced to powder, has a specific gravity of 1·51. The specific gravity of pure starch is 1·51; that of the sugar of starch 1·61. M. Payen found dextrine dried at a temperature of 212° Fahr. to consist of 44·3 per cent. of carbon, 6 of hydrogen, and 49·7 of oxygen,—a composition identical with that of starch. We have seen that water, acidulated with sulphuric acid, transforms starch into sugar; and that in this respect, the acid acts precisely in the same way as malted barley, like which, the acid first causes the fecula to pass into the state of dextrine. By checking the reaction at the proper moment, this substance may thus be obtained, as was shown by Messrs. Biot and Persoz. When starch, for instance, is triturated with concentrated sulphuric acid, if the mixture be diluted with half its volume of water, and be left at rest for an hour, alcohol will throw down almost the whole of the starch employed in the state of dextrine.

"M. Payen has remarked that starch is never met with in the vegetable tissues whilst in the rudimentary state; the spongioles, the radicles, the foliaceous buds, the interior of the ovules contain none of it. Nor is starch found in the epidermis, nor in the primary cells of the subjacent tissues. This proximate principle seems to be excluded from those parts of vegetables that are more directly exposed to atmospheric influences: it is only met at a certain depth; and the globules which constitute starch increase in number and in size in the cells most remote from the surface. The subterraneous organs of plants, —certain bulbs, most tubers,—abound in amylaceous matter. It might be maintained that light modified this substance, at the very moment that it was subjected to the vital influence, and that it was only preserved in the dark. On the globules of some species of fecula, there is found a point or hilum, which, according to some observers, serves to fix them to the parietes of the cells which enclose them. It often happens, however, that no hilum can be distinguished, even by the help of the most powerful microscopes; to render it apparent, recourse must be had to desiccation, which, by causing the globular mass to shrink, allows the part carrying the hilum, to project, by reason of its stronger cohesion. M. Payen does not regard the hilum as a point of permanent attachment, connecting the grain of starch to the interior wall of the cell. He considers it as the orifice of the duct by which growth is effected through intersusception. In support of this view, M. Payen observes, that in a great number of vegetable cells, especially in those of the potato, and of the rhizomas, the

globules of starch are developed in such quantity, that it is actually impossible that each of these should be united directly to the inner wall of the cell."

The starch of commerce is extensively used in medicine, in the stiffening of linens, and in various arts. The best of British manufacture from wheat exists in small columnar masses, and is insipid, inodorous, white, soft, friable, and easily broken into powder. The wheat used in making it is either entire or coarsely bruised; and is steeped in cold water till it swells and yields by pressure a milky juice; and it is then subjected to pressure in coarse bags placed in vats filled with water. When all the milky juice is expressed, the bags are removed, the fecula gradually subsides to the bottom, and the supernatant liquid soon ferments, and suffers a resolution of the principles dissolved in it into alcohol and acetic acid. The whole, after fermentation, is poured into tubs called frames; and, after the fecula subsides in these, the supernatant liquid is poured off,—the upper part of the sediment, being dirty and discoloured, is scraped off,—and the rest of the sediment, constituting the main bulk and purest portion of the fecula, is repeatedly well washed, pressed in cloths, and dried by a gentle heat; and during the process of drying, it so contracts as to form itself into the somewhat regular, small, six-sided columns in which it is sold in the shops.—As aliment to the sick and the feeble, or as food to the healthy and the strong, it is far less suitable in this separated and comparatively pure state, than in the modified forms of arrow-root, tapioca, sago, and gruel; but as a demulcent in the way of enema, it serves admirably in its separated form, for either man or beast; and it is used, in both human and veterinary medicine, for alleviating the acrid action of bile in bilious diarrhœa and dysentery, and for sheathing the rectum in cases of abrasion and inflammation of the gut.

STARLING. A genus of passerinous birds, intermediate in character between the sparrow group and the crow group. The common species, *Sturnus vulgaris*, is a plentiful native of Britain, and abounds throughout a large portion of Continental Europe. It flies in large and crowded flocks; and feeds on larvæ, insects, worms, and molluscs; and is of service to cattle by relieving them from the attacks of insects. It is a beautiful bird in both shape and plumage; and can be easily tamed; and may be taught to sing, and even to speak; and is a great favourite with most kinds of bird-fanciers. The total length of the adult male is 8½ inches; the plumage is nearly black, with reflections of green and violet, and with spottings of white or fawn-colour; and the legs are dark reddish brown. The young male, however, has brown grey plumage. The nest is built in church-steeples, under the eaves of houses, in crevices and holes of lofty walls, in rents and openings of ruinous towers, in cracks and fissures of sea-cliffs, and sometimes in pigeon-houses and in hollow trees; and it consists of straw, roots, and dry grass. The eggs amount to four or five, and are each one inch two lines long, ten lines broad, and of an uniform, delicate, pale blue colour.

STAR OF BETHLEHEM. See Ornithogalum.

STAR OF THE EARTH. See Plantain.

STAR-THISTLE,—botanically *Centaurea Calcitrapa*. An ornamental, annual, indigenous plant of the gravelly soils of England. It has a height of about a foot, and carries pink flowers in July and August. It constitutes the type of a subgenus of the centaureas; and is distinguished from all the other species, except those of this subgenus, by the spinosely pinnate structure of its calyx. One frame perennial-rooted species, with white flowers, one hardy biennial species with purple flowers, and five hardy annual species with yellow flowers, all belonging to the subgenus, and therefore sharing the name of star-thistles, have been introduced to the gardens of Britain from Southern Europe, Northern Africa, and the Levant.

STARWORT. See Aster.

STARWORT (Water). See Callitriche.

STATICE. A genus of ornamental plants, of the plumbago tribe. Four species grow wild in Britain; about sixty have been introduced from other countries; and a number more are known. About twenty species which formerly ranked as statices, comprising sea-pink and the other kinds called thrifts, now constitute the genus armeria. The indigenous statices are popularly called sea lavenders; a few of the introduced species are either annuals, biennials, or evergreen undershrubs; and most of the others are evergreen herbs, either quite hardy or requiring only the protection of a frame, and principally carrying blue flowers, in summer, at the height of from 6 to 15 inches.

The common sea-lavender, or marsh wild beet, *Statice limonium*, is an abundant, evergreen, herbaceous indigen of the muddy sea-shores and marshy estuaries and river-mouths of England. Its root is woody, thick, tough, reddish, and astringent, and sends out many strong fibres, which strike deep into the ground; its leaves rise from the root-crown, and are ovate-lanceolate, smooth, leathery, glaucous, and from two to five inches long; its stem is naked, and rises upwards of a foot high, and divides into many branches, which again divide into smaller branches toward the top; and its flowers grow in slender spikes on the extremities of the sub-branches, and are ranged above one another on one side of the stalk, and come out of narrow covers like sheaths, and have a fine blue colour, and bloom from May till August, and are succeeded by oblong seeds.—The netted sea-lavender, *Statice reticulata*, is an evergreen herbaceous indigen of similar situations to the preceding, but is far less abundant, and occurs chiefly on the eastern shores.

Its leaves are lanceolate and about 3 inches long, and lessen gradually to both ends; its stem is 4 or 5 inches high, and divides into many spreading branches; and its flowers grow on short spikes, and profusely cover the branches, and have a whitish blue colour, and bloom in July and August.—The two-nerved sea-lavender, *Statice binervosa*, is an evergreen herbaceous indigen of the chalky cliffs of England, about a foot high, and carrying blue flowers from June till September, but is rare.—The dwarf sea-lavender, *Statice nana*, is also a rare, evergreen, herbaceous, blue-flowered indigen, but has a height of only about 3 inches.

The broad-leaved sea-lavender, *Statice macrophylla*, was introduced to Britain a few years ago from Madeira, and is one of the largest and most showy of the exotic species. It is a very desirable greenhouse plant, and has rapidly come into great celebrity; but, even in a greenhouse, is impatient of the occasional rigours of our climate when forming its young leaves late in autumn. The leaves are large, obtuse, and spathulate, and taper at the base, and sit closely round the erect shrubby stem, and constitute a dense, handsome, tufty mass of foliage; the flower-stem forms a large branching panicle, two or three feet high, with branches and peduncles of a flattened shape and broadest upwards; and the flowers are borne in an aggregated position on the ulterior ramifications of the branches,—each with a flat, spreading, rich purple blue calyx, which unfolds five white and somewhat fugitive petals, but remains itself on the plant for months.

STAVESACRE. See Larkspur.

STEADING. See Farm-Buildings.

STEAM. The hot elastic vapour of water. A notice of its many economical uses, and of the mighty achievements which have been effected by it in modern times as a motive power, and of the vast accessions of convenience and produce and wealth which it now brings to man in traffic and manufacture, would possess surpassing interest, but does not belong to the design of our work. Its principal actual uses hitherto, in matters connected with the garden and the farm, are the heating of hothouses, the cooking of food for cattle, and the driving of the machinery of the farmery; and its principal prospective use, in connexion with the cultivation of the soil, is the impelling of implements for ordinary field tillage, for subsoil-ploughing, and for the breaking up of bogs and other waste lands. See the articles Hothouse, Steam-Engine, Steaming-Apparatus, and Steam-Ploughing. "That the steam-engine," said the author of four papers on the application of steam to the purposes of husbandry, published about thirteen years ago in the Quarterly Journal of Agriculture, and designed to evoke general interest in the experiments which were then a-foot in steam-ploughing,—"That the steam-engine would, at no very distant day, supply the place of animal labour in agriculture, and become as mighty an instrument in augmenting the productiveness of the soils, as it has proved in creating and economizing manufactures, in navigating the ocean, and in travelling on land, was many years ago predicted by Franklin,—a prediction reiterated by Davy, and latterly acknowledged and enforced by many distinguished agriculturists. The successful application of Mr. Heathcoat's invention to the culture of bogs,—the most repellant and obstinate of waste land,—leaves no doubt of its applicability to soil already in cultivation. Coals are now procurable throughout Great Britain, at prices which have caused the steam-engine to be extensively introduced as a substitute for animal labour in many of the processes connected with husbandry. Thrashing, cleaning, and grinding corn, hay-chopping, turnip-slicing, &c., are now performed by small engines fixed on farm premises. Even the churn has its steam-engine managed by the dairy maid; and so great is the advantage arising to the dairy farmer, from the regularity of motion, and economy produced by it, that hundreds of small engines for this familiar purpose alone, are used in the North of England and in Scotland. But these are humble savings compared with the benefit to be derived from the vast steam power which may be brought to bear on the soil itself. Those agriculturists who are acquainted with the effects produced by the valuable sub-soil plough recently invented by Mr. Smith of Deanston, will readily appreciate the importance of an invention which will enable him to employ that kind of plough at a much diminished cost per acre. Mr. Smith's plough with steam power, will effect a revolution in agriculture. Implements of husbandry have hitherto been restricted in form, weight, and dimensions, to the powers and manageableness of a team of horses. A new class of instruments will take their place; the stiffest soils may be broken up and pulverized to any desired depth; strong clays, the natural wheat lands, may be profitably cultivated, rendered more fertile, and fitted to bear a better and more systematic rotation of crops."

STEAM ENGINE. The use of fixed steam engines, of from four to eight horse power for impelling thashing machines, is now common on large farms in the north of England and the south of Scotland; and the use of both fixed and portable steam engines, of two, three, and four horse power, for impelling the several machines of the farmery, is pretty general in many of the best parts of the centre and south of England. Steam power, next to water-power, is the most desirable for the thrashing machine; and, in consequence of both its greatness and its steadiness, it affords scope for the construction of the machine being of the most admirable description. See the article Thrashing. A non-condensing fixed engine is the most simple, and at its first

cost the most economical; but a condensing one, notwithstanding its greater expense, is the most desirable. A fixed engine, whenever its power can be made fully and generally available for the uses of the farmery, is more profitable than a portable one; for when a convenient building containing the chaff-cutter, the turnip-slicer, the corn-crusher, the cake-crusher, the bone mill, the flower mill, the cider mill, and other useful machines immediately adjoins the barn, all, as well as the thrashing-machine, can be conveniently driven by the engine, and the apparatus for steaming and cooking can at the same time receive its full supply of steam from the boiler; and the fixed engine, besides being very much cheaper at first than the portable one, is ever after more easily kept clean, and managed with less trouble. Yet when the machines to be impelled cannot be kept around one spot, a portable engine is exceedingly convenient and of great practical value; and may be obtained from the manufacturers completely mounted on a carriage with wheels and shafts, for easy removal, with one horse or two according to the size, from place to place in the same manner as carts or waggons. Dean of Birmingham's four-horse power portable steam-engine is very simple, safe, efficient, and durable, and excellently adapted for agricultural purposes. It may be styled a double engine, being mounted with two steam cylinders, thereby dispensing with the heavy fly wheel, and rendering it much more portable, and easily drawn by two horses. Its power is sufficient for driving several of the smaller machines of the farmery, such as chaff cutters, corn cutters, turnip cutters, cake breakers, and bone mills, at the same time; and when employed in thrashing, with an adequate machine, it will be found equal to six or eight horses. Its price is £140; and the working parts of it may be enclosed in iron, at an extra charge of £5. Dean's two horse power portable steam-engine will be found to answer the purposes of many farmers fully as well as one of greater power, being equal to the performance of much more work in cutting chaff and turnips, bruising corn, grinding, &c., than is required to be done upon farms of moderate extent; and when employed in thrashing, it has been declared by many farmers to be equal to four horses. It is more portable than engines of larger power, and is drawn with ease by one horse. Its price is £80. Dean's three horse power portable steam-engine, is also an exceedingly useful farmer's engine, and calculated to drive the usual four horse thrashing machines to much greater advantage than by animal power. Its price is £110. These steam engines being simple, and free from complicated movements, are easily managed and not liable to get out of order. They are fitted with superior metallic pistons, thus obviating the trouble and risk of packing, and with metal side valves in lieu of steam taps; and they will be found much more durable and efficient than engines with vibrating or oscillating cylinders.

STEAMING APPARATUS. The advantages of cooking the food of horses and cattle and pigs, —in small quantities by boiling, and in large quantities by steaming,—are noticed in the articles Boiling, Food, Feeding of Animals, Horse, and Hog. A common apparatus with open boiler to steam food for from ten to twenty horses, may consist of a cast-iron boiler of 40 or 50 gallons in capacity, a sheet-iron steaming-pan of corresponding capacity, an ordinary furnace similar to that of a washing-house, and a crane for lifting off the steaming-pan. The boiler has a double edge or lip, forming a groove about 2 inches deep and 1½ inch wide, running quite round the mouth; and it is set on the furnace. The steaming-pan has a bottom like a large-meshed sieve, fixed into it at about 1½ or 2 inches from its lower edge; it is furnished with an iron bow, attached to gudgeons placed a little below the line of the centre of gravity of the vessel, so that it may be easily overturned when suspended by the bow, for the convenience of emptying it, and is retained in the upright position by a catch; and it has a close cover of wood or of sheet-iron. In using the apparatus, both the boiler and its groove are filled with water; and the steaming-pan is then placed on the top of the boiler, its lower edge falling into the groove, the contained water forming a hydraulic lock or seal, preventing the escape of steam, at a pressure a little above that of the atmosphere. The furnace being kindled, the water in the boiler soon produces steam, which, rising into the upper vessel, pervades every part of it, and being continued for a sufficient length of time, produces the desired effect. This in the case of potatoes will require from 30 to 48 minutes. The crane is worked in the usual manner, and by means of a rope or chain, a man can remove the pan with its contents; and, while thus suspended, the catch of the bow being disengaged, the contents are discharged into a trough prepared to receive them. One advantage of this kind of apparatus is, that the boiler being open, can be applied to the purpose of boiling grain or other substances, or for any purpose in which hot water may be required.

Some close-boiler apparatuses for steaming have hemispherical boilers of cast-iron; and others have malleable iron boilers of the common waggon shape. The latter, though a little more expensive in the first cost, are, in many places, the most economical for fuel; and hence their adoption may be regulated by the price of fuel in the localities where they are to be used. The steaming vessels may be varied to suit situation and circumstances; and may be either chests of deal, chests of sheet-iron, or casks; the last in most cases will be found the most suitable. The other auxiliary apparatus, as steam-pipes, water-cistern, valves, stop-cocks, &c. may be adopted of such materials as shall be most conveniently pro-

cured; and if a special water-cistern be not used, the boiler must be filled through a funnel and stop-cock at each operation. The furnace may be set either on the right or the left side of the steaming-house, or in the middle of it, according to the position of the chimney; and the steaming vessels may be distributed as the situation requires. A good variety of boiler to steam for from 10 to 16 horses is 3 feet 4 inches long, 18 inches wide, and 21 inches high, and is set lengthwise in a brick furnace; the fire-grate being placed under the front end of the boiler, and a flue carried from that quite round, before entering the chimney. By this arrangement, the fire or heated air is held as long as possible in contact with the boiler, which takes up the greater part of the heat evolved from the burning fuel; and it is worthy of remark, that the effect of the fuel depends much on the proper construction of the furnace and flues, to bring out the greatest effect from a given quantity of coal. The boiler is provided with a man hole, to the door of which the steam-pipe is attached; and both can readily be removed at pleasure. It is also furnished with a safety-valve, which need not be loaded above 2 lbs. to the square inch. A feed-pipe is also attached by a coupling screw to the boiler, and its other extremity to the bottom of the water-cistern, placed at not less than 6 feet above the level of the boiler. One end of a rod is jointed to the projecting end of a lever above the water-cistern; and to the other end of this rod, after passing through a small stuffing-box in the top of the boiler, is attached a stone float, or a hollow copper ball, immersed in the water of the boiler. The opposite end of the lever is connected to the rod of a valve, placed at the bottom of the cistern, closing the entrance to the feed-pipe; and the rods at the two ends of the lever are duly balanced with the float on the one side, and the valve on the other. When the surface of the water in the boiler falls by evaporation, or any other cause, the float losing the support of the water, falls along with it, and opens the valve at the mouth of the feed-pipe, letting a quantity enter until the surface again rises, carrying up the float to its former position, which, through the medium of the lever, shuts the valve, and so cuts off further supply, until a repetition of the operation is required by further evaporation. As an additional security, two gauge-cocks are inserted into the boiler; and these have their inward extremity prolonged downward to such length, that when the boiler is in a proper state, the one terminates in steam, the other in water, so that the one cock, when opened, emits steam, the other water. If too much water is introduced, the steam-cock will blow out water, a part of which may therefore be drawn off; and if the water-cock blow out steam, the water has fallen too low in the boiler, indicating some defect in the action of the feed-pipe, and that a supply should be introduced. For the convenience of drawing off water from the boiler for any purpose, a nozzle is attached to it, by which a supply can be got at any time when the boiler is in operation. The pipe which conveys the steam from the boiler to the steaming vessels may have a swan-neck curvature, and should not be less than 2 inches in the bore, and must send off a branch to each steaming-vessel or receiver. The steaming vessels — if casks are used, which are the most convenient—are suspended by gudgeons between posts, poised in such a manner, as to make them easily overturned, for the purpose of discharging the contents; and each is furnished with a false bottom perforated to admit the steam; while a short nozzle, of about 4 inches long, of 1½ inch pipe, is fitted to the real bottom of the receiver, projecting outwards; and the connection between this and the steam-pipe is formed by means of a piece of copper or tin-plate tube, 6 inches long, which slides externally upon the branch of the steam-pipe,—and when the end of the branch is brought to coincide with the nozzle, in the bottom of the receiver, the sliding piece is pushed forward till it embrace both parts. The size of the casks will be regulated by the quantity required to be done; but the boiler here described will supply steam for three casks of from 30 to 40 gallons each. The covering of the receiver is by no means of importance; a wooden cover, with two or three folds of thick sacking, or an old sack, thrown over it, does quite as well as a steam-tight cover. The true bottom of the casks should be perforated with a few holes, to allow the escape of condensed water, which also carries off the colouring matter of the potatoes. When the operation is concluded, the steam-pipes are disengaged; the ends may be stopped with a wooden plug,—or by the stop-cocks, when such are used; but, at the same time, proper attention must be given to the fire, that the production of steam may be checked. The casks are now overturned, and the contents discharged into a trough, or what is better, into a large close wheel-barrow.—In this kind of apparatus, it is evident that the boiling of any substance cannot be done in the boiler itself; but it is well known that any substance can be boiled in a separate vessel, by introducing steam to it, either directly to the liquid that it contains, or by applying the steam through metallic pipes, or into a vessel surrounding the first. These, however, are attended with considerable expense; as distinct vessels from those for steaming roots, &c. must be employed. It has also been ascertained, though perhaps not generally known, that grain of any kind cannot be dressed or cooked by dry steam applied to the dry grain. If the steam is at a low pressure, or a little above that of atmospheric, a species of parching is produced on the grain so treated; and if steam of very high pressure is applied, the grain may be entirely carbonized.

An intermediate, and very simple process, has, however, been found, whereby grain of any sort can be completely boiled, which is done by soaking the grain in water for a period of from six to twelve hours, according to its state of dryness, and then placing it in the receiver described for steaming roots, and applying steam for an hour; and thus we are provided with a simple and efficient steaming and boiling apparatus, applicable alike to the cooking of juicy roots, or tubers, and dry grains.

Chesterfield's portable steaming apparatus consists of a tripod-mounted, cylindrical, chimney-crowned boiler, a suspended, frustra-conical steaming-pan, and a connecting elbow-pipe between the two; and has in the chimney an opening for the supply of fuel,—on the top of the boiler an opening for the supply of water,—in the lower part of the boiler a tap for drawing off water,—below the boiler an opening of the fire-grate,—and in the lower part of the steaming-pan a pipe for carrying off the pernicious extract of potatoes. This apparatus is both cheap and convenient; and will be found especially beneficial to farmers, butchers, and other feeders of pigs and cattle; and is calculated to supersede in many cases the fixed furnace as it can be removed at pleasure from one part of the homestead, or of the farm, to another; and, from the simplicity of its construction, there is not the least danger of its getting out of order. Another important consideration is the great saving effected in consumption of fuel, as 8 or 10 sacks of potatoes can be steamed with 1 cwt. of coals. The boiler may at any time be used separate from the steamer where a large quantity of hot water is required for any purpose, and may with perfect safety be removed to any place at pleasure.

STEAM-PLOUGHING. Two principal attempts to apply steam-power to ploughing were commenced, about seventeen years ago, by John Heathcoat, Esq., in bog reclamation, and several years later by John Upton of Southwark in general tillage. But we can afford to quote only a general notice of each; and must refer any of our readers who wish a fuller account to the 7th volume of the Quarterly Journal of Agriculture, and the 12th volume of the Transactions of the Highland Society.

"The principal machine in Mr. Heathcoat's invention is locomotive, and so contrived as to be capable of travelling on the surface of bogs, the consistence of which would be insufficient, previous to a long and expensive drainage, for sustaining the weight of horses. The moving power is steam, generated from the peat and water of the bog itself. The diggings from the drains furnish abundance of fuel; and the drains yield an unfailing supply of water. The prime agent, steam, is thus obtained at the cheapest possible rate; the local fuel requiring no transport, and the water no outlay in reservoirs or other constructions, to ensure a constant provision. By far the greater part of the power of the engines fixed on the machine is available, and employed to actuate the ploughs or other agricultural implements. These are moved at right angles to the line of progress of the machine, not dragged after it; the machine itself remaining stationary whilst the ploughs are at work between it, and two small auxiliary carriages, in the manner to be presently described. In commencing the reclamation of a bog, a roadway is to be first traced out in a suitable direction for the proposed operations. This is done simply by forming two drains parallel with each other, and about seven yards apart. The principal machine is launched on this roadway. No metal or material of any sort is necessary for its solidity; the machine rests on the raw bog, and bears on so large a surface of it that its buoyancy is insured. It also consolidates and dries the roadway by its pressure. The two auxiliary carriages are stationed (where space permits) at a distance of about 480 yards asunder; one on each side of the principal machine, and parallel with it. Each carriage is furnished with a large wheel, or pulley, round which a band passes, proceeding from, and returning to, the principal machine, whence it derives its motion by proper apparatus. These bands are connected with the ploughs, or other agricultural implements, which are drawn to and fro between the machine and the auxiliaries. One quarter of a mile of land in breadth, exclusive of the roadway and headlands, is thus operated upon on the two sides of the machine. The auxiliary carriages travel on four wheels, resting on planks, which form a moveable railroad. One of the planks is let into a shallow trench cut in the bog, against one side of which plank some friction rollers, fixed on the carriage, press in order to resist the pull of the engines. Ploughing is the first agricultural operation. To accomplish this process in a thoroughly mechanical manner, and to adapt it to steam power, it was necessary to contrive peculiar ploughs, furnished with sharp working knives, which divide every root and fibre of the bog plants, to the depth of 9 inches, and turn over a furrow slice of 18 inches in breadth, completely reversing the surface, and turning the heather side downwards. The underlying heath, moss, and other bog-herbage facilitates the discharge of water, and permits the rain and air to penetrate the furrows. Drains are formed as the ploughing proceeds, that the vast quantities of water liberated by that process may be immediately carried off. After lying a few months in this state, exposed to the action of the atmosphere, the ploughed surface is found to be so considerably pulverized, that little remains to be done to fit it for the reception of grass-seeds. The complex operations necessary to prepare the soil for the culture of other and more important crops than grasses, will also be materially simplified and

economised by awaiting the natural decomposition of the soil, which is so greatly expedited by this system of ploughing as a first process. It establishes a general under-drainage, which, with the assistance of numerous shallow gutters discharging into proper drains, will speedily create a soil on the surface of the wettest bogs. The machine and auxiliaries remain stationary during the time occupied by the ploughs in taking two furrows; they are then, severally, put in motion, and made to advance in three parallel lines, in order to keep pace with the breadth of land turned over, and to pull the ploughs accurately straight. The machine is impelled by the engines, and each auxiliary by its attendant man, who also shifts on his planks as occasion requires. The machine and its auxiliaries have thus to be moved over a space of 18 inches only, whilst the ploughs have travelled 440 yards, and turned over 220 square yards of land 9 inches in depth; in other words, the machine and auxiliaries have to be moved only 11 yards, in the time that the ploughs have travelled 5½ miles, and turned over a statute acre of land. The ploughs perform their work at the rate of two miles an hour, and are subject to very few stoppages; so that 8¾ acres, nearly, of bog would be ploughed up in a day's work of 12 hours, or, taking the average of daylight throughout the year, and making a liberal allowance for hinderances from weather and other causes, one machine would plough up 2,000 acres in a twelvemonth."

"Mr. Upton's steam-plough," said the prospectus of that gentleman's invention, "is worked by his patent lever steam-engine, and his air furnace boiler. If a single-shared plough, the space occupied by the entire machine will be 4 feet long by 10 feet; if for trench ploughing, the dimensions will be the same; if for ploughing two, three, or more parallel furrows at once, then the breadth and length will be about 5 feet by 12 feet. The work done by the trenching plough will be equal to any spade husbandry; and that by the parallel shares will be found very superior to any horse ploughing; inasmuch as the ground will not be trod and rammed down by horses' feet; and as the steerer or ploughman, &c., will ride on the machine, the land will be left as open and light as possible, and resemble that of garden culture. To the steam-plough a harrow, drill, and seed-box can be attached when requisite, and the entire operation performed at one going, when it is for the last ploughing, without trampling the soil. The spots left in the angles of the field by Upton's steam-plough will be smaller than by any horse-plough, as the steam-plough will turn, if a single share, in thrice the breadth and length of a common wheelbarrow; and if a three-shared plough, it will turn in the space of a small one-horse cart. The simplicity of construction and small number of parts composing this steam-engine and boiler, and the great safety and security of the latter, will prevent the necessity of frequent or expensive repairs, as the only parts of the apparatus most liable to wear and tear are the ploughshares, the soles, coulters, and harrow tines, which will only require the same repairs as if drawn by horses. The engine and its boiler is calculated to go 50,000 miles, or more, before any repairs could be wanted, unless from accident or unfair usage; and whenever, from long use, very much worn, if the boiler were to burst, it could only extinguish its own fire without injury to any person close to it. The plough will require one steady man to direct or steer it, and a tractable boy to attend the fire and turn the steam off and on occasionally, the engine being of the most simple and efficient construction. The water-tank will require replenishing now and then, and perhaps fuel will be required two or three times in the course of the day, and the boiler is admirably constructed for burning either wood, peat, or coke, or coal may be used. The single plough is calculated to do two acres per day, and as the person will not be fatigued by walking over the rough ground, nor have any horses to rub down and feed after coming home from the field, they could remain out a longer time. The double plough would do four acres, and the three-shared plough would do about six acres per day. The counter or trench plough would do about two acres per day; but as it would be equal in power to the double-shared plough, it would require the same quantity of fuel and expense. The land cultivated by this plough would doubtless be found from its efficiency to produce crops nearly if not quite equal to spade husbandry; and it would in such cases pay for the steamer the first season." The locomotive-engine was contrived also to be detached at pleasure from the ploughs, and employed in drawing manure carts to the field and carts laden with produce to the market. "And I think," said the inventor, "it might be so modified by further improvements as to be made subservient to many of the farmer's wants. It might perhaps be made available for the cutting of roots and fodder for stall-fed and other cattle; for thrashing, winnowing, grinding corn, and pumping water, &c. In case of the last ploughing, when it is intended to sow and harrow in the seed at one going, the same power would effect the whole work, only requiring the aid of the boy, who must otherwise be engaged in driving the harrow horses, but which horse labour and horse injury done to the soil would be done away with, and a further saving per acre effected by the steamer. The additional boy at the steam-harrow would be required to lift up the harrow occasionally, and take up the weeds, and put them in a basket hung to the machine, until arrived at the headland, where a spare cart might be placed to receive them, and which the engine would take out of the field every evening, or as many times per day as was necessary."

STEARINE. The constituent of oils and fats which is solid at common temperatures. See the article Oil.

STEEL. The hard carburet of iron; that is to say, a compound of iron and carbon. Its discovery was antecedent to the origin of authentic history. Pliny says that, in his time, the best steel came from China, and the next best from Parthia. A manufacture of it existed in Sweden as early as 1340; but it is the general opinion that the process for converting iron into steel, called *cementation*, originated in England. The furnace in which iron is converted into steel, has the form of a large oven, or arch, terminating in a vent at the top. The floor of this oven is flat and level. Immediately under it there is a large arched fire-place, with grates, which runs quite across from one side to the other, so as to have two doors for putting in the fuel from the outside of the building. A number of vents, or flues, pass from the fire-place to different parts of the floor of the oven, and throw up their flame into it, so as to heat all parts of it equally. In the oven itself, there are two large and long cases or boxes, built of good fire stone; and in these boxes the bars of iron are regularly stratified with charcoal powder, ten or twelve tons of iron being put in at once, and the box is covered on the top with a bed of sand. The heat is kept up, so that the boxes and all their contents are red hot for eight or ten days. A bar is then drawn out and examined; and if it be found then sufficiently converted into steel, the fire is withdrawn and the oven allowed to cool. This process is called *cementation*. The bars of steel formed in this way are raised, in many parts, into small blisters, obviously by a gas evolved in the interior of the bar, which had pushed up, by its elasticity, a film of the metal. On this account, the steel made by this process is usually called *blistered steel*. The bars of blistered steel are heated to redness, and drawn out into smaller bars by means of a hammer, driven by water or steam, and striking with great rapidity. This hammer is called a *tilting hammer*, on which account, the small bars formed by it are called *tilted steel*. When the bars are broken in pieces and welded repeatedly, and then drawn out into bars, they acquire the name of *German* or *shear steel*. Steel of cementation, however carefully made, is never quite equable in its texture; but it is rendered quite so by fusing it in a crucible, and then casting it into bars. Thus treated, it is called *cast-steel*, and sells at a much higher price than common steel. The process was contrived at Sheffield in 1750, and for a long time kept secret. When steel is to be cast, it is made by cementation in the usual way, only the process is carried somewhat farther, so as to give the steel a whiter colour. It is then broken into small pieces, and put into a crucible of excellent fire-clay, after which the mouth of the crucible is filled up with vitrefiable sand, to prevent the steel from being oxidized by the action of the air. The crucible is exposed for five or six hours to the most intense heat that can be raised, by which the steel is brought into a state of perfect fusion. It is then cast into parallelopipeds about a foot and a half in length. To fuse one ton of steel, about twenty tons of coals are expended; which accounts for the high price of cast-steel, when compared with that of iron, or even of common steel. Every time that cast-steel is melted, it loses some of its characteristic properties; and two or three fusions render it quite useless for the purposes for which it is intended. It has recently been proved that the steel of which the Damascus blades were made, and which was steel from Golconda, owed the peculiarity which these blades have of showing a curious waving texture on the surface, when treated with a dilute acid, to their consisting of two different compounds of iron and carbon, which have separated during the cooling. It is cast-steel in which the process is carried farther than usual, and which is cooled slowly; both common steel and cast-steel are formed, which separate during the slow cooling. The steel is rendered black by the acid, while the cast-iron remains white. This kind of steel can only be hammered at a heat above that of cherry-red. The specific gravity of good blistered steel is 7·823. When this steel is heated to redness, and suddenly plunged into cold water, its specific gravity is reduced to 7·747. The specific gravity of a piece of cast-steel, while soft, is 7·82; but when hardened by heating it red-hot, and plunging it into cold water, it is reduced to 7·7532. Hence it appears, that when steel is hardened, its bulk increases. The colour of steel is whiter than that of iron. Its texture is granular, and not hackly, like that of iron. The fracture is whitish-grey, and much smoother than the fracture of iron. It is much harder and more rigid than iron; nor can it be so much softened by heat without losing its tenacity and flying in pieces under the hammer. It requires more attention to forge it well, than to forge iron; yet it is by its toughness and capability of being drawn out into bars, that good steel is distinguished from bad. Steel is more readily broken by bending it than iron. If it be heated to redness, and then plunged into cold water, it becomes exceedingly hard, so as to be able to cut or make an impression upon most other bodies. But, when iron is treated in the same way, its hardness is not in the least increased. When a drop of nitric acid is let fall upon a smooth surface of steel, and allowed to remain on it for a few minutes, and then washed off with water, it leaves a black spot; whereas the spot left by nitric acid on iron, is whitish-green. Steel is not so easily converted into a magnet as iron; but, when once converted, it retains its magnetic properties much longer.

Numerous investigations have, at different periods, been made concerning the composition of

steel. In an elaborate dissertation by Monge, Berthollet, and Vandermonde, it is asserted that good hammered iron consists of *iron* free from all heterogeneous matter; that steel is a combination of iron and carbon; and that cast-iron is a combination of iron with carbon, in which the proportion of carbon is greater, and the iron not wholly free from oxygen. Dr. Thomson gives the following as the composition of cast-steel:—

Iron, ...	99
Carbon, with some silicon, . .	1
	100

It is a very desirable thing to combine the extreme hardness of steel with the toughness and tenacity of iron. This is done by welding them together. It is in this way that edge tools are made. A bit of steel is welded to the iron on that side of the plate or bar which is to be worked into an edge; or the surface of a piece of iron is converted into steel by cementation, and the process is stopped before the carbon penetrates so far as to convert the whole piece into steel. This is called *case-hardening*. The piece of work, when nearly finished, is covered with a paste made of combustible matter. Certain animal substances, as horns and hoofs, chopped hair, bone, shavings, &c., are made up into a paste. The iron is covered with it, and the whole wrapped up in clay. This is first dried and hardened before the fire, and then put into a forge, and kept in a low red heat for an hour or two. When taken out, the surface is converted into steel. In this way almost all the parts of gun-locks are treated. Besides the superficial hardness that they thus acquire, it is well known that they have much less friction than while in the state of iron, and they are much less liable to rust. Every kind of iron is not suited to the manufacture of steel. English iron does not answer at all. The iron which answers best is made at Danemora, in Sweden, from the magnetic iron ore. The whole of the yearly produce of the Danemora mines, amounting to 8,000 tons, is imported into Britain, and converted into steel.

The *natural steel*, or *German steel*, is an impure and variable kind of steel, procured from cast-iron, or obtained at once from the ore. It is much cheaper than the cementation steel. It has also the property of being easily welded, either to iron or to itself. Its grain is unequally granular, sometimes even fibrous; its colour is usually blue; it is easily forged; it requires a strong heat to temper it, and it then acquires only a middling hardness. When forged repeatedly, it does not pass into iron so easily as the other kinds. The natural steel yielded by cast-iron, manufactured in the refining houses, is known by the general name of *furnace steel;* and that which has only been once treated with a refining furnace, is particularly called *rough steel*, and is frequently very unequally converted into steel. The best cast-iron for the purpose of making natural steel, is that obtained from the brown hæmatite, or from the sparry iron ore. If it contains manganese, this is thought to be an advantage. It should be of a grey colour. White cast-iron does not yield steel, unless its charge of carbon is increased, either by stirring the melted metal with a long pole, and keeping it melted a long time, that it may absorb charcoal from the lining of the furnace, or by melting it with dark-coloured iron. Black cast-iron yields a bad, brittle steel, unless the excess of carbon that it contains is either burnt away, or it is mixed with finery cinder. The cast-iron to be converted into steel is then melted in blast furnaces, and treated nearly the same as if it were to be refined into bar-iron, only the blast is weaker; the tewyre, instead of being directed so as to throw the wind upon the surface of the melted metal, is placed nearly horizontally; the melted metal is kept covered with slag, and is not disturbed by stirring. When the iron is judged to be sufficiently refined, and is grown solid, it is withdrawn from the furnace and forged. The natural steel made directly from the above-mentioned ores, in small blast furnaces, is a good steel for ploughs and similar machines: the best of it is excellent for saws and cutlery. The most esteemed steel of this kind comes from Germany, and is made in Styria. It is usually sold in chests or barrels, two and a half or three feet long.

STEELYARD. A balance for determining the weight of bodies by means of a single standard weight. See the article Balance. Ruthven's steelyard, invented upwards of 20 years ago, by Mr. John Ruthven of Edinburgh, is well suited to the use of farmers and of persons who deal in farm-produce. It comprises a longer arm, a shorter arm, a weight moveable along the former, a scale suspended to the latter, a rod with looped vertical uprights in the ends for suspending and confining the arms, and a stand for supporting and poising the whole machine. The longer arm has so limited a range of motion at its extremity as to prevent the jerks and long vibrations to which common steelyards are subject; the weight cannot escape at either extremity of the arm, and consequently can never be mislaid or lost; and the scale is ingeniously contrived to open one end and discharge its contents at a touch, and is therefore very convenient for weighing grain, flour, small seeds, and similar commodities.

STEEP. Any saline or medicated liquid for the immersion of seed-corn preparatorily to its being sown. See the articles Seed, Smut, and Wheat.

STEER. A young bullock.

STEG. A gander.

STELIS. A genus of tropical epiphytous plants, of the orchis family. Four or five species have been introduced to British collections, —but, as compared with other orchidaceæ, are

more curious than beautiful; and a number more are known.

STELL. See Sheep-Stell.

STELLARIA. See Stitchwort.

STEM. The part of a plant which rises from the root, and sustains the foliage, flowers, and fruit. In some plants, it is awanting; in others, it is identical with the mere flower-stalk; and in others, it bears only part of the foliage, the rest being radical; but in all the more perfect ones, or indeed in the great majority of all sorts of phænogams, it comprises a great mass of important organism intermediate between the root and the inflorescence. It is ligneous in trees and shrubs, and constitutes their trunk or boll; and it is herbaceous in herbs,—annual in some perennial-rooted ones, and perennial in others. It is cylindrical in some plants, compressed in others, and quadrangular in others; solid in some, tubular in others, and jointed or knotted in others; naked in some, and leafy in others; simple in some, and compound or branched in others; robust in some, and slender in others; upright in some, nodding in others, and decumbent in others; rigid in some, and flexuose in others; self-supported in some, climbing in others, twining in others, and creeping in others.

STEMODIA. A genus of tropical plants, of the figwort family. Two perennial species and five or six annual ones—chiefly with blue, red, or white flowers—have been introduced to British collections; and about as many more are known; but they do not possess any particular interest.

STENOCHILUS. A genus of ornamental, Australian, evergreen shrubs, of the myoporum family. Three species, the smooth-leaved, the long-leaved, and the spotted, all red-flowered and less than five feet in height, have been introduced to Britain; and the first has the recommendation of a capacity to bloom throughout most of the year; and all love a somewhat peaty soil, and are propagated from cuttings. The name stenochilus alludes to the narrowness of the flower-lip.

STENORHYNCHUS. A genus of ornamental tropical plants, of the orchis family. Two species, the showy and the orchis-like—the former scarlet-flowered and blooming from April till June, and the latter carmine-flowered and blooming in May—have been introduced to the hothouses of Britain; and both are terrestrial-rooted, evergreen and very beautiful, and love a soil of sandy peat, and are propagated by division of the plant. The name signifies 'narrow beak,' and alludes to the pointed form of the stigma.

STERCORARY. A collection of putrescent manure in a position of security from injury by the weather. A good ordinary kind of it, recommended ages ago by judicious and reflecting agriculturists, is simply a dung-pit instead of a dunghill, either dug in a bed of clay or chalk, or well-paved in both the bottom and the sides,—protected by a shed from rain, and by the nature of the ground from the influx of springs or of surface water,—filled up progressively with the cleanings and drainings of the farm-yard, both solid and liquid,—and augmented or modified at frequent and proper intervals with layers of mould or other mineral manure of a kind suited to fix the gases of the putrescent substances, and to render the whole contents of the pit peculiarly adapted to the soil and crop to which it is intended to be applied. See the articles Manure, Liquid Manure, and Farm-Yard Manure.

STERCULIA. A genus of ornamental, exotic, evergreen ligneous plants, of the byttneria tribe. About twenty species, varying in natural height from 6 to 35 feet, have been introduced to British gardens; and a number more are known. The name sterculia is formed from a word signifying 'ordure,' and alludes to the excessively disgusting fetor of some of the oldest known species. A bark used in India for some medicinal purposes, and popularly called 'stink-bark,' and possessing a smell very similar to ordure, has been thought, though perhaps erroneously, to be the produce of *Sterculia fetida*,—a species 8 feet high, with palmate leaves, introduced to British collections toward the end of the 17th century. The seeds of one or two species, though evolved out of a very fetid inflorescence, are eaten by the Hindoo peasantry, and occasion the carpels which contain them to be popularly called hill cocoa-nuts. The carpel of *Sterculia alata*—a very stately tree—is a very curious fruit,—an orbicularly pear-shaped follicle, about 4 inches long and about as much across, somewhat compressed, with walls half an inch thick, containing large and rayedly-disposed seeds. The majority of the introduced species have ovate or oblong leaves, either entire or three lobed; and most of the remainder have cordate five-lobed leaves;—and all love a soil of peaty loam, and are propagated from cuttings.

STERIGMA. A genus of interesting herbaceous plants of the cruciferous order. The woolly and the twisted species, both curious, yellow-flowered, hardy biennials, of about a foot in height, blooming from April till July, were introduced to Britain about 30 years ago from Astracan and Iberia. They are nearly allied to wallflowers.

STERNBERGIA. A genus of bulbous-rooted, ornamental, exotic plants, of the amaryllis order. Four species—all yellow-flowered, autumnal bloomers of from 3 to 8 inches in height, loving a soil of rich mould, and propagable from offsets—have been introduced to Britain from the north of Africa and the south and east of Europe.

STEVIA. A genus of ornamental exotic plants, of the eupatorium division of the composite order. Upwards of 30 species have been introduced to Britain, principally from Mexico and New Spain.

A few are herbaceous evergreens, with subshrubby stems and pink flowers; most are perennial-rooted herbs, with annual stems, and either pink, white, violet, or purple flowers; and nearly all have a height of between 15 and 30 inches, and bloom in the end of summer and beginning of autumn. Most love a soil of peaty loam; and all are propagated by radical division.

STEWARD. See AGENT.

STICKLEBACK, — scientifically *Gasterosteus*. A genus of fishes, of the mailed cheeked family of acanthopterygians. The common stickleback, *G. aculeatus*, abounds in the fen-ponds, canals, new ditches, and other fresh-water accumulations of many parts of Britain; and is obtained in large quantities and extensively used for manuring land and feeding hogs. It has commonly a length of not more than two or three inches. Its back and sides have an olive green colour; and its belly is perfectly white. It has three dorsal spines; and one variety of it has scaly plates only on the pectoral region,—while another variety has them to the very end of the tail.—The lesser stickleback, *G. pungitius*, is a very small fresh-water fish, and has nine very short dorsal spines.—The larger stickleback, *G. spinochia*, is a salt-water species of a slender and elongated form, with fifteen short dorsal spines.

STICTA. A genus of lichens, of the cænothalamous tribe. The lung species, *S. pulmonacea*, is useful for dyeing. It has a reticulated structure, an olivaceous colour, and a size of about two inches, and grows on the trunks of trees throughout the year. Eight other species inhabit the trees and woods and rocks of Britain.

STIFLE-JOINT. The lower joint of the hind leg of the horse. It comprises the tibia or lower bone of the thigh and the patella or knee-pan; and it is much strengthened by some of the tendons of the strongest muscles of the upper part of the thigh passing into it and over it, and co-operating with its own proper ligaments to give it force and tension.

STIGMA. The summit of the style or pistil of a flower. It has no cuticle, and is either humid or papillose.

STIGMAPHYLLUM. A genus of ornamental tropical plants, of the Barbadoes cherry tribe. It takes its name from the foliaceous structure of its stigma. Two species, the auricled-leafed and the awn-leafed, the former about 10 feet high, the latter about 20 feet high, and both yellow-flowered, evergreen climbers, propagable from cuttings, have been introduced into British collections from Brazil.

STILE. A fixed means of enabling a foot passenger to go over or through a fence. It has a great variety of forms; but ought, in every instance, to be substantial, facile, and of such structure as neither to weaken the fence nor to induce any passenger to make trespasses or dilapidations. A common and very good kind consists of strong bars about three feet wide, fixed in upright posts, with a step nailed crosswise to stumps on each side, and raised half way up the frame; but a much more convenient and, in all respects, better kind, is a cage wicket. See the article CAGE-GATE.

STILLINGIA. A genus of exotic yellow-flowered plants, of the spurge tribe. A herbaceous evergreen and a deciduous shrub of it have been introduced to British collections from North America, and two tall evergreen shrubs from China and Ceylon; and one of the latter, the tallow-bearing, though a mere hothouse curiosity with us, possesses economical adaptations in its native country. This genus was named in honour of Dr. Stillingfleet.

STILT, — *Himantopus Melanopterus*. A rare and curious bird, of the long-billed family of waders. Its total length is about 13 inches; its legs are remarkably long and slender; and, together with the toes, have a pink colour; its head, neck, and breast, and the under parts of its body are white; and its back and wings are nearly black, tinged with green. It has sometimes been killed in some of the counties of England; but is only an occasional visitor to our shores; and has not been often or closely observed in its habits.

STIMULANT. A substance which increases the irritability of the living animal or vegetable fibre. In veterinary medicine, internal stimulants require to be used with great caution; but external ones, in many cases, are obvious and valuable remedies. See the articles CORDIAL and EMBROCATION.

STING. A small, tubular, awl-shaped organ or process, for discharging a minute quantity of a powerfully venomous fluid. The sting of an insect is nearly allied in structure to an ovipositor; and the sting of a vegetable is a process of the stem or leaf, and is well exemplified in the common nettle. See the articles INSECT and NETTLE.

STINKING HOREHOUND. See BALLOTA.

STIPA. A genus of grasses, constituting, with the genera aristida and chætaria, the family Stipaceæ in the one-flowered paniculate tribe. One species grows wild in Britain; about a dozen species have been introduced from America, Siberia, and Continental Europe; and about twenty-five more are known. All the introduced species are hardy; all but one are perennial; about one half have a height of two or three feet; and the majority have a curious or interesting appearance; but none are fitted to rank as agricultural plants.

The feathered species, popularly called feather-grass, *Stipa pennata*, inhabits the dry mountainous rocks of some parts of Britain, and has a place as an ornamental or curious plant in many a garden, yet is a doubtful native. Its root is fibrous and perennial; its culms are from 12 to 24 inches high, and thickly covered with foliage; its leaves are long, narrow, acute, roughish, and

dark green, and grow in dense tufts on the culms; its sheaths are striated and very long; its stipules are oblong and obtuse; its flowers grow in simple, erect panicles, six or seven in each panicle, and bloom in July and August; and its awns are nearly a foot long, and have a beautiful feather-like appearance, and adhere to the seeds, and serve as sails to waft them on the breeze over a wide extent of country. "When a seed with its feathered arrow alights on the ground, it enters the soil vertically, and, in a few hours, the base and sulcated part of the awn becomes twisted and the feathered portion becomes horizontal; in consequence of which it is blown round by the autumn winds like a vane, and every turn screws it farther down into the earth,—for the hollows and ridges which, when it remained upon the plain were only longitudinal sulci, have now given rise to the hollows and elevations, in a word, to the threads of a screw. Thus it is moved down, and whatever is gained is prevented from being undone by a reverse motion of the vane, in consequence of the stiff hairs upon the glume, which act as barbs." The feathered awns distinguish the plant in general appearance from all other grasses, and render it worthy of a place on the flower-border, and are sometimes worn by ladies instead of feathers. The seeds abound in some of the pastures of Hungary, and, when carried about by the wind, make a lodgment on the back of a sheep, and work their way through the wool and skin and flesh into the intestines, and excite throughout the system a powerful morbific action, which the veterinarians of the country call *stipæ noxa*, and which shows itself in restlessness, sleeplessness, and loss of appetite, and terminates in fever, inflammation, and death. The plant, however, does not readily grow in Britain from seeds, and requires to be propagated in gardens by parting and planting the roots. It is of small value for agricultural purposes; and when raised on a heathy soil in the Woburn experiments, it yielded per acre 9,528 lbs. of produce at the time of flowering, 3,454 lbs. of dry produce, and 409 lbs. of nutritive matter.

STIPE. The stalk of a fern or the stem of a fungus.

STIPULE. An appendage of the base of a leaf-stalk. It commonly resembles a miniature leaf, with a subulate termination; but has a less firm texture than a leaf.

STITCHWORT, — botanically *Stellaria*. A genus of herbaceous plants, of the carnation tribe. A number of species which formerly belonged to it are now assigned to other genera; but eight species still belonging to it grow wild in Britain, nearly 20 have been introduced from other countries, and a good many more are known. All are white-flowered; most have a height of between 6 and 20 inches; nearly all present a weedy appearance; and some are annuals, some biennials, and some annual-stemmed perennials.

The common stitchwort, or common chickweed, or mediate chickweed, *Stellaria media*, is one of the most vivacious, generally diffused, perennially blooming weeds of our cultivated lands, and even of the most contrasted soils and situations of a waste nature; and it particularly abounds in the neglected nooks and borders of gardens. Its root is annual, small, and tapering; its stems have seldom a height of more than a few inches in the garden, but sometimes attain a height of twenty in the woods; its foliage is small, pale green, and profuse, and spreads out in all directions; and its flowers are small, stellate, and white, and bloom from March till December. The herbage is refused by goats, disrelished by sheep, eaten by cows and horses, and greedily devoured by hogs; and it is said to be nutritive, and suitable for being boiled and eaten in the manner of spinach, —and has the reputation, when boiled in vinegar and salt, of possessing virtue to cleanse eruptions of the hands and limbs. The leaves and tender stalks, and especially the seeds, are eaten by poultry and wild birds. The flowers serve, in some degree, as a natural barometer; for when rain is approaching, they remain closed,—and in dry weather, they are regularly open from about nine o'clock in the morning till noon.

The forked stitchwort, *S. dichotoma*, is an annual weed of the cultivated grounds of Britain, and has a height of about 20 inches, and blooms throughout the greater part of the year.—The grove and the Holostea stitchworts, *S. nemorum* and *S. holostea*, are perennial-rooted indigens of the moist woods of Britain, and have a height of about a foot, and bloom from April till June.—The marsh or glaucous stitchwort, *S. glauca*, is a perennial-rooted indigen of the wet meadows of Britain, and has a height of 8 or 10 inches, and blooms from May till August.—The grass-leaved stitchwort, *S. graminea*, is a perennial-rooted weed of the hedge-banks of Britain, and has a height of about a foot, and blooms from April till June.—The scape-bearing stitchwort, *S. scapigera*, is a perennial-rooted indigen of the brook-banks of some parts of Scotland, and has a curious appearance and a height of only 2 or 3 inches, and blooms in June and July.—The cerastium-like stitchwort, *S. cerastoides*, is a perennial-rooted indigen of some of the lofty mountains of Scotland, and has also a curious appearance and a height of 5 or 6 inches, and blooms in June and July.

STOAT,—scientifically *Mustela Erminea*. A small quadruped of the weasel genus and digitigrade family of Carnivora. It closely resembles the weasel in structure, habits, agility, and mischievous pursuit and destruction of hares, game, and poultry, and does not differ much from it in size, and is often confounded with it in name. Its height is about two inches; its tail is $5\frac{1}{2}$ inches long, very hairy, and tipped at the point

with black; the edges of its ears and the extremities of its toes have a yellowish white colour; and the other parts of its body exactly correspond in both shape and colour to those of the weasel. In the most northern parts of Europe, it regularly in winter changes the colour of all its body except the point of the tail to white, and is then called the ermine; and its fur at that time is sought after by hunters as a well-known and valuable article of commerce. It sometimes is found white during winter also in Britain, and is then commonly called the white weasel; but its fur in this case is of small value compared with that of the foreign ermine, being very inferior in at once thickness, closeness, and whiteness. Pontoppidan says respecting the Norwegian stoat or ermine, "It lives among the rocks; his skin is white except the tail, which is tipped with black. The furs of Norway and Lapland preserve their whiteness better than those of Russia, which soon acquire a yellowish cast; and upon this account the former are in greater request even in Petersburgh. The ermine catches mice, like the cat, and when practicable carries off his prey. He is peculiarly fond of eggs, and when the sea is calm, he swims over to the islands, which lie near the coast of Norway, where there are vast quantities of sea-fowls. It is alleged, that, when the female brings forth on an island, she conducts her young to the continent upon a piece of wood, piloting it with her snout. This animal, although small, kills those of a much larger size, as the reindeer and bear. He jumps into one of their ears when they are asleep, and adheres so fast by his teeth, that the creatures cannot disengage him. He likewise surprises eagles and heathcocks, by fixing on them, and never quitting them, even when they mount in the air, until the loss of blood makes them fall down."

STOCK,—botanically *Mathiola*. A genus of ornamental plants, of the cruciferous order. Two species grow wild in Britain; nearly twenty have been introduced from other countries, principally those around the Mediterranean; and nearly a dozen more are known. Six or seven of the species in Britain are hardy annuals; five or six are biennials; and the rest are herbaceous evergreens or subshrubby evergreen undershrubs. A few have a height of only from 3 to 8 inches; and the rest have a height of from 12 to 30 inches. The petals of two are obovate and purple; those of seven are oblong and yellowish purple; and those of the rest are obovate, and either white, red, scarlet, purple, violet, or various-coloured. One of the indigenous species, the scollop-leaved stock, *Mathiola sinuata*, is a violet-flowered biennial of about a foot in height, inhabiting the sandy sea-coasts of Cornwall and Wales, and blooming from May till August; and the other, the hoary gilliflower or great sea-stock, *Mathiola incana*, is a purple-flowered, evergreen undershrub of from 12 to 25 inches in height, inhabiting high maritime cliffs in the south of England, blooming from May till November, and comprising three very distinct varieties, with respectively white, scarlet, and variegated flowers.

But the chief interest of the genus is concentrated in the well-known stocks or gilliflowers or stock-gilliflowers of the flower border. These have long been high favourites with all sorts of florists, and are fondly cultivated in all sorts of flower-gardens, from the humblest to the most princely, for the sake of both their beauty and their exquisite fragrance. They were originally introduced from the South of Europe, but they include many varieties, and have been abundantly hybridized; and they comprise three great groups, —ten-week stocks, queen stocks, and Brompton stocks, which are regarded by some botanists as separate species, and by others as broadly marked and very permanent varieties. All are capable of being brought to flower and killed by frost in the same year in which they are sown, and so appearing as annuals,—and of not flowering till the second year, and continuing to live and flower during several years, and so appearing as short-lived perennials; but the ten-week kinds are peculiarly liable to die after one flowering, and are therefore commonly called annuals,—and the other kinds seldom thrive or bloom so well after the first flowering as before, and are therefore commonly called biennials. All were classed by the old botanists with wallflowers; but they are readily distinguishable from them by the hoariness of their leaves, by the comparative succulence or fleshiness of their stems, by the greater compactness or less shrubbiness of their habit, and by the greater brilliance and warmer colour of their flowers.

The following are Miller's descriptions of the three principal stocks:—"The ten weeks' stock rises with a round smooth stalk about a foot high, dividing into several branches upward. These are garnished with spear-shaped hoary leaves, rounded at their ends, and placed without order, sometimes being almost opposite, at others alternate, and frequently three or four together, of unequal sizes. At the ends of the branches the flowers are produced in loose spikes, placed alternate. The empalement is large, erect, and slightly cut into several acute parts at the top. The petals are large and heart-shaped, spreading open in form of a cross. The pods are long, cylindrical, and have a longitudinal furrow on one side, which opens in two cells, filled with flat roundish seeds, having a thin border. It flowers in July and August, and the seeds ripen in October. Of this sort there are the red, the purple, the white, and striped, with single flowers, and the same colours with double flowers. If the seeds are sown at two or three different times, the flowers may be continued in succession near three months.—The queen's stock rises with a strong stalk, which is almost shrubby, a foot high or more, having oblong, spear-shaped, hoary

leaves, which are frequently waved on their edges, and turned downward at their extremity. From the stalk are sent out many lateral branches, garnished with the same shaped leaves, but smaller. These side branches are each terminated by a loose spike of flowers, each having an oblong woolly empalement, and consists of four large roundish petals, indented at the end. These usually appear in May and June, but the same plants frequently continue flowering most part of summer. The seeds ripen in autumn, and the plants generally perish soon after; but when any of them grow in dry rubbish, they will last two or three years, and become shrubby. Those with single flowers are not worth preserving after they have perfected their seeds. The flowers of this sort vary in their colour; some are of a pale red, others of a bright red, and some curiously variegated; but those of the bright are generally most esteemed. There are always a great number of double flowers produced; if the seeds are well chosen, frequently three in four of the plants will be double; and as they divide into many branches, make a fine appearance during their continuance in flower.—The Brompton stock rises with an upright, strong, undivided stalk to the height of two feet or more, garnished with long hoary leaves, reflexed, and waved on their edges, and at the top form a large head. Out of the centre of these arises the flower stalk, which, when the plants are strong, is frequently a foot and a half long, putting out two or three short branches toward the bottom. The flowers of this kind have longer petals than any of the other sorts, and are formed into a pyramidal spike; but those with single flowers are loosely disposed, because the flowers having but few petals, do not fill the spike, as those do which are double; for these often have so many petals, as to render each flower as large and full as small roses; and when they are of a bright red, make a noble appearance, being excelled by none of the flowery tribe. But the plants of this sort produce but one spike, in which it differs from all the other kinds."

Almost all persons who profess to grow large quantities of stocks in pots for the market have favourite subvarieties of their own, which cannot easily or at all be identified with the normal plants of any botanical species or leading varieties; and all the principal seedsmen of the present day, besides vending many sorts of ten-weeks, queen, and Brompton, sell also great groups under the name of German, smaller groups under the name of Prussian, besides numbers of special sorts under such names as Victoria, Prince of Wales, New Emperor, New European, Scarlet intermediate, Purple intermediate, Chamois, and Superb. The German florists have been eminently successful in raising and perpetuating very numerous and distinct varieties,—especially in the tints and shades of the colouring of the flowers; and seeds of annual stocks alone imported to Britain from Continental Europe produce many distinct shades from white to deep red, from white to deep purple, and from white to dark slate colour, and run into no fewer than between 40 and 50 different characters, all tolerably true.

"The most extraordinary fact with regard to the culture of stocks," says the editor of the Horticultural Magazine, "is that they come double from single seed, or rather from seed saved from single ones, and that without the slightest reference to there being any double ones near them or in the same ground. Many are almost superstitious as to the period at which they are to be sown; and it has long been proved to our satisfaction that culture has something to do with it, because we have seen a packet, or rather packets, of seed divided between two people, one producing nearly all double, and the other nearly all single. The ordinary mode of sowing ten-week or annual stocks is on a slight hot-bed; and when they are up to give them plenty of air, even by entirely removing the glasses in fine weather. Those who want them early in spring sow in the autumn; those for summer bloom are sowed in spring. We have no conceit about the particular period. Here they may be sown in March, April, May, and even June, and grow till they are large enough to plant out, giving them no more water than is absolutely necessary to keep them from flagging. When planted out, they should be watered in well, and then, being placed 9 inches apart, they will only require to be kept clean from weeds, and grow until they flower. If you are choice in the purchase of your seed, you may, of the German stocks alone, have forty very distinct shades of colour. The Prussian stocks are not so numerous. In saving seed, select the single stocks with the widest petals, and with five petals, if you can find them, which is not at all uncommon; but you may as well plant double brickbats as double stocks, to influence the seed of the single ones you save from. The autumn-sown stocks may be sown a month apart in the same way, for keeping in pots through the winter. All you have to do is to see them strong enough to plant into pots before the winter is too cold for them. They require no heat, but they are, in that young state, unable to stand much frost. Plant three in a pot if you fear the quality, that you may be able to draw one or even two single ones out, should there be such, and take out the weakest of them if they all run double. Among the best cultivators of the biennial stocks, we have known some who grew them in pots for sale, and we have seen hundreds in frames growing well, and nearly all double. Of all these we have made various inquiries, and it was evident that while they were in the seed-bed they partly starved them if for planting out in the open ground; but, if for potting, they put them out rather small than otherwise, and starved them there; that is to say, they kept them all the early part of their

career what we should call rather short of moisture. Some persons have been in the habit of sowing the spring ten-week stocks broad-cast in the bed they are to grow in, and, when they become large enough, drawing them out to thin them to 9 inches or a foot apart. The objections to this are, that the stocks are not left in even rows; for this is next to impossible. Those drawn out generally run more double when carefully taken away and planted. The best way is to water the bed well first, and in half an hour you may draw them out without damaging the roots. It has been thought by many that the check which stocks get under the transplanting system is beneficial in producing the double flowers; but, generally speaking, we think high culture induces it. Certain it is, we never saw a self-sown stock come double when left to bloom in the place in which it came up; and some kinds are very apt to come single, and cannot be prevented. Biennial kinds of stock should be sown in May or June, and as nearly as possible that time in the next year they will flower. The months mentioned as those in which they bloom, supposes them to be sown at the ordinary time for biennials, that is, midsummer, or rather later. These are best sown in a good sound border of loam and peat, though the soil of a kitchen garden not fresh dunged will do for them. Here they may remain until they have made some considerable growth, and from thence taken to where they are to bloom, whether this be in beds, borders, or pots. They must, if potted, be only one in a pot, of the forty-eight size; and in the spring, all that indicate double flowers should be transferred to size twenty-four pots, as they will grow very much, and the flowers be greatly assisted by the additional room. But the Giant Brompton, and some of the large kinds of biennial stock, are much too large for pots, and will grow, on good ground, three, and occasionally four, feet high. They should be planted out time enough to establish themselves in the ground before the winter sets in, and are only fit for extensive gardens. The biennial stocks are well worth propagating from cuttings, and they produce flowers in a much more dwarf state. These are taken from the side shoots and come soon after the bloom; indeed, if left on the plant they would bloom. When taken for cuttings, they should be stripped off with part of the heel, or cut very close to the plant, and placed under a hand-glass; but they should always be taken as soon as they are large enough to handle well; and if they should indicate bloom before they have grown to any size, which they will sometimes, it must be pinched out as soon as you can get hold of it. When they have rooted well, they may be planted out the same as seedlings."

STOCK. The stem of a living, growing, young tree, used for receiving a graft or bud. See the articles GRAFTING and BUDDING.

STOCK. Moveable property possessed in connexion with productive industry. The stock of a farm is usually classified into living and dead, —the former comprising the animals, old and young, and the latter comprising the implements, manures, and vegetable produce. See the article LIVE STOCK.

STOCK DOVE. See PIGEON.

STOCK FARMER. A farmer whose business mainly consists in rearing live stock, and who therefore occupies a pastoral farm. See the articles FARM and FARMER.

STŒBE. A genus of ornamental, Cape-of-Good-Hope, evergreen undershrubs, of the thistle division of the composite order. Four species, all about 2 feet high, and blooming in the early part of autumn, have been introduced to Britain; and they love a soil of peaty loam, and are propagated from cuttings.

STOKESIA. A beautiful blue-flowered, evergreen, herbaceous plant, of the thistle division of the composite order. It constitutes a genus of itself, and takes the specific name *Cyanea* or azure-flowered. It is a native of Carolina, and was introduced to Britain in 1766. It has a height of about 2 feet, and blooms in the early part of autumn; and it thrives in any common soil, and is propagated by radical division.

STOLON. A shoot from the side, summit, or collar of a root, extending laterally either within the soil or upon its surface, and terminating either in a tuber or in a young perpendicular root. The string which connects a potato tuber with the root is a good example of a subterranean, tuber-ending stolon; and the runner of a strawberry-plant is a good example of a surface, root-ending stolon.

STOLONIFEROUS PLANT. A plant which naturally propagates itself by means of stolons. The strawberry-plant and fiorin grass are good examples.

STOMA. See STOMATA.

STOMACH. The first or digesting portion of the alimentary canal of an animal. The arrangement of it into four parts in ruminants, together with the manner in which these severally and co-operatingly perform its aggregate function, is noticed in the article RUMINATION; the first and the third parts of it in ruminants are described in the articles RUMEN and MANYPLUS; and the physiology and offices of it in animals in general are discussed in the article DIGESTION.

The horse's stomach has peculiarities of size, situation, structure, and habit which ought to be well understood by all persons who manage horses. It is remarkably small in proportion to the other parts or general bulk of the body; and has a form somewhat similar to the bag of a bagpipe; and is situated behind the diaphragm, principally on the left side, with its expellent orifice extending across the spine to the right; and being pressed by every motion of the diaphragm, and necessarily offering resistance to that motion during all the periods of its disten-

tion by food, its singular smallness is a beautiful provision to prevent painful or injurious interference with the process of respiration. "The situation of the stomach," remarks Youatt, "will at once explain the reason why a horse is so much distressed and sometimes irreparably injured, if worked hard immediately after a full meal. The stomach must be displaced and driven by every contraction of the diaphragm or act of inspiration, and in proportion to the fulness of the stomach will be the weight to be overcome, and the labour of the diaphragm, and the exhaustion of the animal. If the stomach is much distended, it may be too weighty to be forced sufficiently far back to make room for the quantity of air which the animal in a state of exertion requires. Hence the frequency and labour of the breathing, and the quickness with which such a horse is blown, or possibly destroyed. Hence also the folly of giving too full a meal, or too much water, before the horse starts on a journey or for the chase, and, in like manner, the absurdity and danger of that unpardonable custom of some grooms to gallop the horse after his drink, in order to warm it in his belly, and prevent gripes." The stomach has two surfaces, which may be called its sides, though one is posterior, and the other anterior,—and two extremities, a larger and a smaller,—the latter of which receives the œsophagus or gullet, while the former ends in the duodenum, and, when the stomach is distended, extends farther back than the other. The stomach is externally covered by the peritoneum, which adheres closely to it by means of its cellular membrane; and it has within this a coat or system of muscular fibres, which are stronger than those of the stomachs of oxen and sheep. These fibres run in various directions, but are principally longitudinal and circular; and the latter are very thick and strong around the extremity in which the gullet terminates. The inner covering of the stomach consists of two portions, a cuticular and a villous. The cuticular portion extends over nearly one half, and is possessed in common with the horse by only such other animals as live chiefly on grain; and it may be considered as, in a slight degree, a kind of gizzard, acting compensatorily for the want of power of thorough mastication. The horse, notwithstanding the grain-grinding structure of his teeth, is urged by the wants of his system to feed greedily and swallow hastily, so that he does not sufficiently masticate his food; and he therefore enjoys a peculiarity of coating over his stomach which acts in a triturating way, and ensures the digestion of half ground grain. The insensibility of the cuticular coat occasions many medicinal substances which act with great power or virulence on man, such as emetic tartar, verdigris, sugar of lead, blue vitriol, white vitriol, and arsenic, to have little effect on the horse. The villous coat is much more extensive than the muscular, and is thrown into comparatively large folds; and these are largest toward the gullet, and become less toward the duodenum, and form there a kind of valve which prevents a return of the food and regulates its passage out; and they afford in the aggregate an ample secreting surface for the gastric juice, and everywhere apply it equally to all the parts of the substances which are undergoing digestion. The terminating fibres of the gullet pass obliquely through part of the muscular and cuticular coats, and then arrange themselves at the orifice in a manner intermediate between that of a valve and that of a sphincter muscle, so as to present an insuperable obstacle to the regurgitation of food. A horse, therefore, cannot vomit.

STOMACHIC. A medicine which strengthens the stomach and excites appetite. In veterinary practice, it is closely allied to a cordial, but produces a more durable effect.

STOMACH (Inflammation of). See Gastritis and Braxy.

STOMATA. The minute orifices or pores in the epidermis of the leaves of plants. Most, though not all, have an oval outline, or appear like areolæ, with each a slit in its centre; but the edges seem like a sort of thickened sphincters capable of opening and shutting, and the slits vary in both size and form. They usually occur on the under surface of leaves which are freely exposed on all sides to the air, and on the upper surface of leaves which float on water; and they perform very important functions in the general economy of vegetable life and growth. See the article Absorption in Plants.

STONE. A piece of rock. When water-worn and small, it is a pebble; when water-worn and large, it is a boulder; when scarce, small, and beautiful, it is a gem; when cubical, compact, quarried and cut for building or for sculpture, it is a block; when stratified and fashioned into a slab for a floor or a foot-path, it is a paving-stone; and when laminated and split and dressed for roofing, it is a slate. A mass of pebbles, from the size of a pea to that of a small potato, constitutes gravel; a deposit of this with intermixtures of sand and organic remains constitutes gravelly soil; and any kind of diluvium or alluvium, containing either loose or landfast boulders or a considerable proportion of large pebbles, constitutes stony soil. See the article Gravel.

"It has been argued, and is not yet determined," said a distinguished agricultural writer of eighty years ago, "whether stones are hurtful or beneficial to arable lands. Examples are not wanting on both sides of the question; though in general, it seems rather to be carried for them. However, nothing can excuse leaving a stone in any ground so large as to interrupt the plough. If they are very large, they should be blown to pieces with gunpowder, and then be carried off. Some spots very fertile in several kinds of grain seem to consist of nothing but stones; and in-

stances are given of fields being rendered barren by taking away the stones which covered them. Theophrastus accounts for this in a hot country, where it happened to the Corinthians, by saying, that the stones shelter the earth from the scorching heat of the sun, and thereby preserve its moisture. The same holds true even in our colder latitudes, where the heat of the sun is less apt to hurt us; and Mr. Evelyn is clearly of opinion that husbandmen rather impoverish than improve those grounds which are almost covered with stones, especially where corn is sown, if they pick them off too minutely, because they thereby expose the land too much to the effects of heat and cold. Certain it is, that a moderate mixture of small gravel preserves the earth both warm and loose, and prevents too sudden exhalations. But it seems highly probable that there must be some further reason, beyond what has yet been assigned, for the benefit arising from stones." One 'further reason' is the assisting to keep open spongy and adhesive soils—and this has ceased to apply to the multitudes of once wet fields which have been improved and dried within the modern era of subsoil draining; and another and far more important 'further reason' is the composition of most of the kinds of stones,—and this both explains how the constant though slow disintegration of basalts, greenstones, clay porphyries, and especially calcareous limestones by the combined action of tillage implements and the weather maintains fertility by supplying alkalies and salts for the nutrition of crops, and shows how the presence of sandstones, quartzose stones, and pieces of stubborn plutonic rocks either adds very little powdery matter of any description to the soil, or adds only such as contains scarcely any food for crops, and therefore does no appreciable good. Some stones, too, which have a widely different composition, or resolve themselves into widely different granules, from those of the mineral portion of the diluvium or alluvium in which they are imbedded, may do good by correcting the mechanical defects of the soil by their debris, or by contributing principles which chemically co-operate with those in the soil for producing recombinations of an alimentary nature to plants. Hence, any farmer who has a fair knowledge of the nature and functions of soils, and of the composition of all the most common kinds of rocks, may generally determine at a glance whether the stones in any field are beneficial; and any farmer who has not such a knowledge, and who wishes to determine whether the clean removal of stones in any case will do good or harm, ought by way of experiment to clear them away from one corner or small portion of the field, and observe the effects upon the next year or two's cropping.

The lifting and removal of large landfast boulders is a principal operation in the reclaiming of some waste lands, and has sometimes been found perplexing and very difficult. An excellent apparatus for lifting the stones is a tripod machine described upwards of twenty years ago, by Professor Low, in the Edinburgh Philosophical Journal and in the Transactions of the Highland Society. This consists simply of a set of sheerpoles, about 14 feet in length,—a powerful tackle of pulleys suspended from the head of the poles,—an iron plug, comprising a ring, a flat part, and a cylinder of about an inch in diameter and two inches in length hooked to the lower block of the tackle, —and a windlass six feet or more long, worked by levers, and having at each end a winch. It is placed over the stone to be raised by extending the poles on three sides, and then the windlass is attached. If only a very small part of even a huge stone appear above the surface, it is enough; a circular hole must be drilled in it, with a mallet and the common steel-boring chisel of masons, about a sixteenth part of an inch less in diameter than the cylinder of the iron plug, and about two inches deep, and as nearly perpendicular as possible; the plug must be driven into the hole, to the depth of an inch or so, with a stroke or two of a hammer; and with no other fastening than this simple plug, the turning of the winches by as many persons as may be requisite will tear up the boulder, no matter though it should be of the utmost weight which a waggon can carry, through every opposing obstacle. The secure holding of the plug seems to result principally from the friction produced by the elasticity of the stone between the surfaces of the plug and the bore, and is so far exactly similar to the firm holding of a pin driven into a block of timber, with the difference that the elastic power of stone is incomparably greater than that of any timber; and perhaps it also arises partly from the circumstance that a line passing through the axis of the cylindrical plug will seldom if ever coincide with the vertical line passing through the stone's centre of gravity when suspended by the plug, so that the plug's resistance upon the sides of the bore is oblique, and occasions difficulty or impossibility of disengagement so long as the stone is in suspension. But when the stone is let down again, either on a cart or on the ground, the plug is loosened and let out simply by a smart stroke or two of a hammer near the edge of the bore. "We shall often be surprised, in trying the experiment on large pieces of rock," says Professor Low, "to observe with how slight a seeming hold of the stone the masses will be torn up. Sometimes the iron pin is not driven above the fourth part of an inch into the stone before it becomes immoveable, and capable of raising a weight of many tons from the earth. When we consider the greatness of the elastic power of the harder stones, as shown by this simple experiment, we may perhaps wonder that the ingenuity of man has not hitherto more applied so surprising a property to practical uses. It appears that, with a

little piece of iron driven into a stone, with a force which a child might exert, the largest vessels might be moored,—that, by the same means, masses of granite might be nailed as it were together, with a force which could hardly be overcome, and rocks suspended as by a touch in the air."

Another facile contrivance for both lifting and removing large landfast boulders is a modification of the well-known sling-cart,—a machine which seems to have been first brought out at Woolwich, and was long ago used there for the removal of heavy ordnance, and was afterwards employed at Arbroath for the removal of the large stones used in the erection of the Bell-Rock lighthouse, and has of late years become common in the constructing of all sorts of huge masonry and great public works. The modification of this machine used for lifting and removing landfast boulders, and invented by Mr. W. F. Robertson of Hazlehead in Aberdeenshire, is described as follows:—"The carriage-wheels are about 7½ feet in height, to admit of the stone being freely suspended under the axle, and are defended by two or three concentric slender rings of iron, attached to the inward face of the wheels, to prevent the stone from chafing the spokes. The shafts are connected by cross frame-work, after the construction of the common open cart, with the exception of the main bar, which in this case is made very strong, and to which the axle of the carriage is attached. On the upper side of the main bar is placed the frame-work of the crab: this consists of two cast-iron cheeks, strongly bolted to the main bar, and carrying a toothed wheel, with a drum or barrel, on which the purchase-chain is coiled. The wheel is acted upon by a pinion, which is turned by the application of manual power to winch-handles. The proportions of the machinery of the crab are such as to enable two men at the handles to raise a stone of three tons' weight. A small platform is attached to the main bar on which the two men stand who work the crab. The purchase-chain, having one end fixed to the barrel of the crab, and a hook at the other end, completes the working parts of the machine. The auxiliary parts consist of a pair of common stone-shears, together with a sling chain of three or four yards in length, a pick-hammer, mattock, spades, &c. When a stone is to be raised, the only preparation necessary is to expose, by digging, as much of it as will admit of the stone-shears getting hold, and, for this purpose, a small indentation is made on each side of the stone with a pick-hammer. The machine is then brought over the stone, the shears hooked on to the purchase-chain, and their hooked extremities brought to take hold of the stone, at the indentations made for that purpose; a rest or prop is also put under the shafts, to ease the horse, and keep the machine steady while loading. The crab is then worked by the two men at the handles, until the stone is raised from its bed, and to such height that the sling-chain can be passed under it; the purchase-chain is then eased off; the shears disengaged, and the sling-chain being now brought to embrace the stone, is hooked to the purchase; and, by again working up the crab, the stone is elevated till it swim clear off the ground. The substitution of the chain for the shears is necessary, in order to allow the stone to be raised sufficiently high; for, though the shears must be used in the first place to raise the stone from the ground, their length prevents it from being raised so high as to admit of transportation. The stone being in this manner suspended, its removal from the field is easy and expeditious." Mr. Robertson found that, when the stones are prepared by being dug about and marked for the shears, he was able to remove from 50 to 60 blocks, each weighing from one to three tons, to the boundary of a field of eight or ten acres in one day, and at an expense not exceeding one-half of what he incurred by any other method. The use of the simple plug-lewis and tackle instead of the stone-shears and chain would perhaps be an improvement; and the drilling of the hole for the plug might not, in the average, cost more than the digging and hammering for the stone-shears.—One of the most obvious of the common methods of dealing with large landfast boulders, as well as with slight, occasional, rocky protrusions, is to blow them to pieces with gunpowder, and remove them in fragments.

STONE. A weight of commodities. The legal stone is 14 pounds avoirdupois; but provincial stones, and stones of particular commodities, vary from 5 to 16 pounds. The old stone of glass is 5 pounds; the old stone of fish is 8 pounds; the old stone of wool, in Herefordshire, is 12 pounds,—in Gloucestershire, 15 pounds,—and, according to statute in the reign of the seventh Henry, 14 pounds; the old stone of beef, in London, is 8 pounds,—in Herefordshire, 12 pounds,—and in the northern counties, 16 pounds; and a common stone, both old and modern, both British and Irish, in the case of some particular commodities, is 16 pounds;—and a ton of stones, long weight, is 21 hundreds.

STONE. A disease. See STONE-IN-THE-BLADDER.

STONECHAT,—scientifically *Saxicola Rubicola*. A British bird, of the warbler group of Passerinæ. Its total length is 5½ inches; its head, neck, chin, and throat are black; its breast is rich chestnut; and the sides of its neck down to the wings are white. It resides in Britain throughout the year. Its nest is built on the ground, at the base of some low bush; and consists of moss, grass, hair, and feathers. Its eggs amount to five or six; and have a pale greyish blue colour,—the larger end minutely sprinkled with dull reddish brown; and each measures about 8½ lines in length, and 7 lines in breadth.

STONECROP. See SEDUM.

STONE-IN-THE-BLADDER. The formation and irritating effects of calculi in the urinary organs. The nature of the calculi is treated in the article Calculus; and the surgical operations for extracting them, in the articles Lithotomy and Lithotrity.

In horses, calculi occur sometimes in the kidneys, sometimes in the urethra, and sometimes in the cæcum, but very seldom in the bladder. Calculi in the kidneys of the human subject naturally fall by their own weight into the bladder; while those in the kidneys of the horse, in consequence of the horizontal position of the abdomen, remain fixed where they are. The presence of a calculus in a horse's kidney is not indicated by any certain symptoms, and cannot be remedied or controlled; but the presence of a calculus in his bladder is indicated by symptoms similar to those of spasmodic colic, and by the irregular discharge and occasional suppression of urine, and may be certainly ascertained by throwing the animal and introducing the hand into the rectum while he lies on his back,—and is capable of being treated in a similar surgical way as in the human subject, but requires to be dealt with by an experienced veterinary practitioner.

In cattle, calculi in the bladder are both much more liable to form, and much more likely to be retained, than in the horse; for they form round the granules of earthy matter which cattle somewhat freely swallow with their food, and they are hindered from naturally passing away in consequence of the comparative smallness and sinuosity of the urethra. Their presence is indicated by much fever, frequent gazing on the flanks, trembling of the hind limbs, ineffectual efforts to evacuate urine, and evacuations of it in small quantities and mixed with blood; and it may be certainly ascertained by introducing the hand into the rectum, and feeling the bladder. In all cases of proper stone in the bladder of ordinary cattle in tolerable condition, the most profitable course is to send them without loss of time to the butcher; but in cases of proper stone in the bladder in valuable animals, or in animals too poor for the shambles, careful lithotomy may be attempted with due regard to the peculiar structure of the ox's urinary organs; and in all cases, which not unfrequently happen, of the calculi passing naturally away, and being detained in small pieces in the urethra, and so obstructing the canal as to endanger life, recourse ought to be promptly had to a suitable surgical operation. A bullock whose urethra becomes obstructed by a piece of calculus may be seen to stretch himself out for a few minutes, to make ineffectual attempts toward evacuation of urine, to stamp his feet as if suffering much pain, and to kick his belly as if suffering from colic. "Unless he is at this time relieved," says Professor Dick, "the pain rapidly increases, inflammation of the bladder follows, and it becomes ruptured either by over-distention, or from its own effort to force out its contents; the urine escapes into the cellular tissue, or the cavity of the belly, producing inflammation of the peritoneal coat, which is followed by dropsy and death. When the operation is to be performed on an ox, the chief circumstance to be attended to is this:—On making the incision on the part where the calculus is retained, it is advisable to draw the skin a little to one side before making the incision through the skin, and, having done this, the urethra may either be raised out from its situation in the loose cellular membrane, with which it is here surrounded, and the incision made into the canal, while it is thus roused, or, if it can be done with readiness, the incision may be continued through all the parts, while they lie in their natural position. This latter operation, however, requires more dexterity than the other, and is also more apt to lead to untoward consequences; because, if the incision is not made freely, and at once through all the parts into the canal, the repeated incisions produce more or less laceration of the parts; and there is a considerable degree of danger that, from this cause, some of the urine, as it escapes after the opening is made, will flow into the cellular membrane, and produce a troublesome if not a dangerous degree of inflammation and infiltration of the tissue. After the bladder has completely emptied itself of urine, the parts may be allowed to resume their natural situation. The skin having been drawn to one side before the operation was performed, will now be drawn over the opening in the urethra, and thus the wound in it will be closed. After the bladder has been emptied, the urine will not again pass along the canal for a short time, and thus the parts will have so far reinstated themselves by adhesion, and a deposition of coagulum, that the urine will at next evacuation flow along the natural passage, and the animal feel but little the effects of the operation."

STONE PINE. See Pine.

STONE WALL. See Wall.

STONY LAND. See Stone and Gravel.

STOOK. See Shock.

STOOL. The living and shoot-producing stump of a timber-tree. See the article Coppice.

STOOP. A prop or post resting on the ground and supporting either a rick or a piece of masonry.

STORAX,—botanically *Styrax*. A genus of ornamental, exotic, corolliflorous shrubs, constituting the type of the small natural order Styracineæ. All the species of this order are handsome ligneous plants; and most are natives of North America. Four true storaxes, all hardy, white-flowered shrubs, have been introduced to Britain; and three more are known.

The officinal storax, *Styrax officinalis*, is a native of the south of Europe and of the Levant, and was introduced to Britain toward the close of the 16th century. It attains a height of upwards of 20 feet in its native regions; but seldom

grows to more than 12 in Britain. Its young shoots have a reddish colour; its branches are numerous and slender, and are clothed with a smooth greyish bark; its wood is finely scented, and exudes a fragrant resin; its leaves stand on short footstalks without any regular order, sometimes singly and sometimes in pairs, and are elliptical, pointed, entire or slightly waved, about 2 inches long and 1½ inch broad, lucid green in the upper surface, hoary in the under surface, and somewhat similar to those of the quince-tree; and its flowers come out in bunches of seven or eight from the sides of the branches, and have a large, monopetalous, funnel-shaped corolla, and emit a delightful fragrance, and bloom in July, but are not succeeded in Britain by any fruit. This plant does best to be raised from seed with the same appliances and care as a greenhouse plant; and becomes fit for taking its place in a final situation of the open ground when it is six or eight years old; and needs a dry soil of sandy loam and a warm and well sheltered spot; but it may be propagated also by layering.

The resinous exudation of the officinal storax has a place in the materia medica under the name of storax balsam, and is used in several pharmaceutical compounds. It possesses somewhat stimulating and expectorant properties, and was formerly prescribed rather freely in cases of catarrh, asthma, phthisis, and menstrual obstruction; but it is now employed principally or solely as an adjunct on account of its fragrance. It is used also in the composition of pastilles. Two kinds of it occur in commerce,—the one in tears, which is pure,—and the other in lumps, which contains intermixtures of sawdust and other impurities; and both kinds are imported from the Levant, and are there obtained from artificial incisions in the bark of the tree. The balsam consists of resin, benzoic acid, and empyreumatic oil; and has a reddish-brown colour, and a pleasant, aromatic, sub-acidulous, slightly pungent taste; and is brittle at the ordinary temperature of the atmosphere, and breaks with a shining, resinous fracture. See the articles Benjamin-Tree, Benzoin, and Pastille.

STORE FARMER. See Pastoral Farm.

STORK,—scientifically *Ciconia*. A genus of large birds, of the cultrirostrous family of grallæ. Their bill is thick and moderately cleft; their mandibles are light and broad, and produce a clash by striking against each other; their legs are reticulated; and their anterior toes, particularly the external ones, are strongly palmated at the base.—The white stork, *Ciconia alba*, sometimes though rarely visits England, but is more common in France, and passes the winter in several countries of Africa. Its total length is about 3½ feet; its general plumage is white; its wing-quills are black; and its bill and feet are red. It builds its nest on towers, steeples, and similar situations, and returns to the same spot in successive years. It destroys snakes and other noxious reptiles, and is greatly venerated on the Continent.—The black stork, *Ciconia nigra*, is also an occasional yet rare visitant of England. Its total length is about 3 feet 4 inches; its general plumage is blackish, with purple reflections; and its belly is white. It frequents solitary marshes, and builds in forests.

STORK'S BILL. See Pelargonium.

STOT. A steer or young bullock.

STOVE. A horticultural building for the protection and culture of tropical plants. See the article Hothouse.

STOVEN. A shoot from the stool of a fallen tree.

STOVER. Fodder from the straw and chaff of thrashed corn.

STOWK. The handle of a pail.

STOWRE. A round of a ladder, a hedge-stake, or a stave in the side of a waggon.

STRAIN, or Sprain. A rupture of the cellular tissue and minute nerves of membranes, ligaments, or muscles. Strains frequently occur in horses,—and much more frequently in those who make sudden and violent exertions than in those who perform only slow and steady work. They do not, as is commonly supposed, consist in extensions of ligaments, but are ruptures of minute cells and vessels, followed by inflammation and swelling. In all kinds and degrees of them, rest is a grand and essential remedy; in moderate ones, embrocations and bandages are usually serviceable; and in very severe ones, bleeding, blistering, and opening medicine are sometimes necessary.

A very bad kind of strain to which horses are subject is noticed in the article Back-Sinews.—A strain in a horse's shoulder is indicated by his extending the limb with difficulty, inclining it a little outward, and carrying his head and neck a little to the one side. An ordinary case of it may require bleeding, the administration of opening medicine, the placing of a rowel in the chest, and the rubbing of the whole shoulder two or three times a day with ammoniated soap liniment or some similar embrocation; and a bad and stubborn case of it, which does not yield to these remedies and to a long continued rest, and which seems to involve a permanent contraction of the muscles, may possibly be alleviated by means of frequent swimming.—A strain in the muscles of the back sometimes accompanies ossification of the vertebral ligaments, and should be treated with bleeding, laxatives, stimulating embrocation, and the use of a fresh sheep's skin on the back. See the article Anchylosis.—A strain of the hip joint, though often identified by ignorant persons with almost every kind of obscure lameness in the hinder parts of the horse, is really of rare occurrence; and when it does happen, it may yield to rest and an extensive blister, but is more likely to prove incurable.—A strain of the stifle joint is indicated by swelling and tender-

ness of the part, and by difficulty in bringing forward the hind leg; and as it is commonly deep seated, it must be attacked by blistering.—A strain of the knee is generally complicated with other injuries of the part, and may require in addition to the common remedies for strains, the application of a large poultice by means of a stocking or a flannel bag. See the article Broken Knees.—A strain of the fetlock joint usually arises from some sudden and violent exertion, as in leaping, and is sometimes accompanied by displacement of the sesamoid bones; and must be attacked by bleeding, physic, and poultices. See the article Fetlock.—A strain of the coffin joint is indicated by the horse's being able to walk soundly while he is very lame in a trot, and by great heat in the foot, extending to the pastern, and sometimes accompanied by swelling round the coronet; and it requires the shoe to be removed, the sole pared thin, and the whole foot, after taking a considerable quantity of blood from the toe, to be wrapped in a large poultice; and if it be very bad or obstinate, it may require also the blistering of the pastern.

Cattle, or even working oxen, are vastly less subject to strains than horses, and do not require to have them treated with the same sedulousness and nicety. Any ordinary recent strain in cattle may generally be cured by frequent fomentations with warm water, and frequent bathings with a mildly stimulating embrocation; a severe one may require to be treated also with bleeding and physicking; and a very deep-seated one must be attacked with a free-rubbing in, every morning and evening, of a powerfully stimulating embrocation, such as one consisting mainly of olive oil and spirit of turpentine, and containing some oil of origanum and some cantharides. A strengthening plaster, in the form of a charge, may also be useful. An ordinary strain in the fetlock of the ox may be reduced by a diligent alternate use of a mild and of a powerful embrocation; but a bad one may require blistering or even the cautery; and if it be very stubborn, and involve considerable lameness, the nerve which comes down to the foot from above the fetlock may be divided so as to destroy sensation.

Strains sometimes, though not often, occur in the fetlock-joint of sheep; and must be treated with rest, fomentation, and poultices; and, if they be very bad, they may also require either a strongly-stimulating application or a mild blister.

STRAMONIUM,—botanically *Datura Stramonium*. A hardy, medicinal, annual plant, of the thorn-apple genus and nightshade order. It is a native of America, but has become naturalized in England, and occurs wild on rubbish and dunghills and by the sides of roads in the vicinity of London and in other places. Its stem is cylindrical, leafy, branching, spreading, and about two feet high; its leaves stand on long, cylindrical footstalks springing from the forks of the stem, and are large, triangularly ovate, sinuated, dark-green above, and pale below; its flowers stand on short erect footstalks, and are axillary, solitary, and large, and have a white funnel-shaped corolla, and bloom in July and August; and its fruit are large, ovate-roundish, four-cornered, fleshy capsules, armed with sharp, awl-shaped spines, and containing each a great number of compressed kidney-shaped seeds. The whole herb has a fetid narcotic odour, and a nauseous bitterish taste; and possesses stimulant and narcotic properties. The root, the leaves, the seeds, the capsules, the whole herb in a dried state, and the inspissated expressed juice of the leaves are variously used in medicine. But both the fresh plant itself and some of the herbal and pharmaceutical preparations of it act with great potency, and have been known to produce convulsions, dreadful delirium, paralysis, and death, and ought never to be used except according to the prescription of a regular physician. An analysis of the plant by Promnitz found 58 parts in 178 to be gummy extractive, 6 extractive, 64 chlorophylle, 15 albumen, 12 resin, and 23 phosphate of lime and magnesia. A peculiar principle called daturine exists in the seeds in the form of a malate; and, when separated, crystallizes with difficulty, yet has been obtained in quadrangular crystals; and it combines with acids to form neutral salts, and is nearly insoluble in water.

STRANGLES. A disease of young horses. It generally attacks them in their fourth or fifth year; and is regarded by some veterinarians as a specific or constitutional disease which every young horse is liable to have once, and which no horse has twice. It commences with swelling under the jaws, cough, dulness of the eyes, and some degree of fever; it passes into semipurulent discharge from the nostrils, soreness of throat, increased swelling, eventual suppuration, and disinclination or inability to drink or to take more than a very little food; and it sometimes becomes so violent and spreading as to prevent swallowing, to threaten suffocation, and to set up inflammation in the lungs, accompanied with very hurried breathing. Many colts at grass get through the disorder without assistance from man; yet even colts which are least seriously affected ought by all means to be assisted, and those who are most seriously affected may require the utmost efforts which veterinary skill and sedulous care can make. Constant fomentation, or the application of large poultices, or the appending of steaming mashes to the head, accompanied with stimulation or blistering of the jaw, ought to be practised till the tumour 'points' and ripens; and then the suppuration should be let out at the point, and a pledget of tow introduced to keep the abscess open for a few days, and the horse allowed only green food, and led occasionally into gentle walking exercise;

and when the symptoms relax and the appetite returns, abundant nourishment may be given, accompanied, in cases of great debility, with malt mashes and tonic medicines. Bleeding, in any of the active stages of the disease, is improper, and may be mischievous except when inflammatory action is indicated at all in the lungs or highly in the approaches to them; and then it becomes requisite for the reducing of the inflammation. "The period of strangles," says Mr. Castley, "is often a much more trying and critical time for young horses than most people seem to be aware of; and when colts get well over this complaint, they generally begin to thrive and improve in a remarkable manner, or there is sometimes a great change for the worse; in fact, it seems to affect some decided constitutional change in the animal."

STRANGURY. Inflammation or spasmodic affection of the neck of the bladder. It sometimes arises in the horse from blistering for other and more serious inflammations; and when it occurs, the horse should receive a dose of Epsom salt, a plentiful supply of linseed tea, and a dose every six hours of opium and camphor made up with treacle and linseed meal into a ball. See the article Inflammation.

STRANVÆSIA. A genus of exotic ligneous plants, of the rosaceous order. The grey-leaved species, *S. glaucescens*, is a hardy, evergreen, small tree, of about 20 feet in height, carrying white flowers in June; and was introduced to Britain about 20 years ago from Nepaul; and thrives in any common soil, and is propagated by budding. It is regarded by some botanists as a hawthorn.

STRAPWORT, — botanically *Corrigiola*. A genus of ornamental, trailing, herbaceous plants, of the purslane family.—The sand or shore strapwort, *Corrigiola littoralis*, grows wild on the southern coasts of England. Its root is annual, small, and tapering; its stems are flaccid, not much branched, and several inches long, and spread in every direction on the ground; its leaves are scattered, simple, linear-lanceolate, obtuse, glaucous, and somewhat fleshy; and its flowers grow in terminal or lateral subdivided or interrupted clusters, and are numerous and often sessile, and have a white, pearly colour, and bloom in July and August.—The Cape and the orpine-leaved strapworts, the former an annual from the Cape of Good Hope, and the latter a perennial from the South of Europe, closely resemble the indigenous species in at once flower, habit, and treatment; and all are propagated from seeds on the open border, in the manner of ordinary hardy annuals.

STRATH. A valley flanked by mountains. The word is Scottish; and is applied in some instances to a glen and in others to a plain,—in some to a single valley traversed by a stream, and in others to a chain or series of valleys without any reference to particular water-courses.

STRATIOTES. See Water Soldier.

STRATUM. See Geology.

STRAW. The dried culms of the cereal grasses, —and, by a loose or extended use of the word, the succulent culms of the cereal grasses, either the dried or the succulent stems of sarcolobous field leguminous plants, and either the dried or the succulent stems of some of the large, grass-like, non-gramineous forage plants. Straw, in the proper sense, is employed mainly and largely for litter and fodder, and very considerably for thatching; and straw in the extended sense, is employed mainly and in various ways for fodder; and they are largely discussed, both in articles on their aggregate uses, and in the articles on the several crops which produce them. See, in particular, the articles Fodder, Food of Animals, Feeding of Animals, Chaff, Haulm, Litter, Hay, Soiling, Horse, Wheat, Oat, Barley, and Rye.

The relative value of different species of straw for fodder is greatly controlled by the character of the soils on which they are grown, by the stage of growth or of ripeness at which they are reaped, by the condition in which they are harvested and kept, by the degree of freshness or of age at which they are used, and by the amount and kind of preparation which they undergo. "It is thought," says the Useful Knowledge Society's Treatise on British Husbandry, "that, when grown on gravelly or rich clay soils, straw is more valuable as fodder than when it is reared on black deep loam or cold moorish land; and it is now generally admitted that it possesses more succulence when the corn is rather green than when it is in a riper state. It is supposed by many that the straw of wheat is the most nutritive; it certainly makes the strongest manure, and is thought to be the best for either steaming or cutting into chaff; although that of oats is usually preferred as more soft and more palatable to cattle. That of barley is so poor and brittle, that it is only employed as litter; it is extremely difficult to save it in any tolerable degree of order; and though it has been said to possess more nutriment than that of wheat, yet, when the crop is fully ripe, the ears break off in handling, which has been contended as sufficient proof that it contains but very little sap. Rye-straw is so scarce in all except the northern counties and some parts of Wales, and is in such demand for thatching, brick-making, &c., that it is but seldom applied to other uses." Straw of any species in a well-harvested and perfectly fresh and sweet condition is greatly better than straw of the same species in an ill-stored or untidy or too old or somewhat musty state; straw cut into small pieces in the form of what is technically called chaff is greatly better than straw in its entire length; cut straw in mixture with some more nutritious substances is greatly better than cut straw alone or in mixture with comparatively innutritious substances; and a mixture of cut straw and more nutritious substances in a

steamed or boiled or otherwise cooked condition is greatly better than the same mixture in a raw condition.

A correct estimate of the relative nutritious values of the different species of straw and haulm, viewed intrinsically or without reference to the diversities in each arising from soil and culture and condition, could be formed only by striking the average of careful chemical analyses of specimens of each species, of the different qualities of it in use; and as this is unattainable and even unapproachable in the present state of our knowledge, an estimate by Veit, one of the ablest Continental agriculturalists, founded on extensive practical induction, may be substituted. "The straw of the common leguminous crops," says he, "especially of lentils, vetches, and pease, is more nutritious than the straw of seed clover. The greener the tips are, the less it is lodged, the better can it be dried and brought in, the more nourishing it is. The straw of lentils and seed-clover is the most preferable. The fine stalk vetch straw is also very nutritious; behind which stands somewhat the pea-straw, with its thicker stalk. All straw of leguminous fruit is particularly a welcome fodder to sheep, on which account therefore it is greatly prized by many sheep-owners, and considered equal to hay.—Oat and barley straw, is the straw for fodder of the cereal crops. Oat straw is most agreeable, and also most nutritious, on account of its peculiar taste for all species of cattle, because on the tips of the panicles are usually found unripe grains, and oats are generally cut before they are fully ripe. Barley straw has, on account of its moisture and short period of vegetation, a high value as fodder, and, other things being equal, is as nutritious as oat straw, if it were not, as is the case, fully ripe before reaping. Yet it is more liable to injure than oat straw, because after reaping it imbibes more moisture from the air and soil.—Straw of summer wheat, summer speltz, and summer rye, for fodder, stands after oat and barley straw; but in many farms, where the straw of the usual species of winter grains supplies the need of litter, it is employed for especially the moister straw of summer wheat, and summer speltz. That of summer rye is less nutritious.—The stalk of maize contains much saccharine matter, and therefore is very nutritious used fine, and agreeable to all kinds of cattle. The cobs, after the corn has been taken off, ground up, are likewise a very nutritious fodder, and the hard stalks may be chopped up for the purpose. Taking all these things into view, it stands next to the straw of summer rye in value as fodder.—Millet straw has a hard stalk, but contains at least as much nutritious matter as the straw of the winter cereals, at the same time that millet is cut before it is fully ripe. Buckwheat, on account of its quantity on a field of less fertility, and if of fine stalk, in which case its value as fodder from its straw being rich with leaves, is enhanced, is as good as the straw of the winter grain. The straw of the usual winter grain crops, as of barley, wheat, speltz and rye, has less value as fodder, and is therefore employed more for litter. Rye straw is the least valuable for fodder of the straw of all the cereals. Bean straw, in case its leaves have not fallen off or are decayed, and the ends of the stalk are green when it is cut, as many experiments have shown, has a much higher value as fodder than is usually supposed. If the very hard stalks are chopped fine, and scalded with juicy fodder mixed with it, the nutritious quality of it is little inferior to that of the straw of other leguminous plants."

The substances suitable to be mixed with cut and cooked straw as food for working animals and for milch cows, are various, and have already been partially discussed in the articles Horse, Cow, and Food of Animals. Some of the most nutritious are crushed oil-cake and the several preparations and mixtures of linseed, cole-seed, and oatmeal. "An American farmer obtained an excellent fattening substance for his oxen, by mixing with a decoction of lint-flower, straw heated in boiling water, colza-powder, and oatmeal, the whole seasoned with a little salt; for the same purpose a jelly has been employed in England, made of linseed, boiled for two hours, after being left to macerate in water during twenty-four hours. It is mixed with straw or wheat chaff. Several experiments of this kind, repeated in America, have afforded successful results in the fattening of cattle. Linseed has been boiled in a quantity of water sufficient to form a jelly of moderate consistence; the boiling should be continued for an hour and a half, and it is necessary to stir the mass frequently, that the seed be not burnt. To two measures of linseed there are added three of bruised barley; and when the whole is well boiled, it is mixed with four measures of chopped straw, and given warm to the animals which are to be fattened. Should they refuse this food, from not being accustomed to it, they are readily habituated to it, by mixing a little molasses with it, and by giving them but a very small quantity at first. Cattle may also be fattened by mixing straw while still moist and warm, with meal or flour, such as of barley, wheat, pease, oats, maize, &c., or with bruised seeds. It is proved that seed given entire produces the loss of a tenth part in nutrition, a tenth part being voided by the animals without undergoing any change. The seeds are bruised by passing them between two cylinders. If moistened and brought to germination, they are more nourishing. When the seeds cannot be bruised, they are rendered more digestible by being steeped in water for half a day. Bread crumbled and mixed with straw, affords a still more nutritious aliment than seed or meal, and it would probably be advantageous to give it in preference. Bran contains little alimentary substance, but it may be

increased by moistening it with water, and allowing it to ferment until it sours. When the object is to feed beasts well without fattening them, the quantity of the above substances, mixed with the straw, is diminished, or they are substituted by others, according to the products of each locality. Thus, pease, vetches, lupines, beans, millet, and especially maize, after being bruised or macerated in water, and mixed with straw, furnish an excellent food. The leaves of cabbage, and various leguminous plants, those of the elm, poplar, ash, maple, and oak, afford an advantageous mixture. Roots, especially carrots, turnips, and potatoes, are not less profitable. In wine countries, the refuse of grapes may also be employed; in short, almost whatever comes to hand of farm produce. Salt ought always to enter into these preparations. The liking which cattle of all kinds evince for this substance, proves how useful it is to their health, and how much it adds to the energy of their digestive powers. The leaves of various plants may be made to undergo preparations, rendering them more inviting and more salubrious to cattle. Those of most of our forest trees, dried, and sprinkled with salt, yield an excellent fodder, which may be mixed with chopped straw. In Prussia and some other parts of Germany, a kind of choucroute is prepared, by putting cabbage, and even clover, in large stone receptacles, after chopping them and sprinkling them with salt. The mixture is then allowed to ferment, and yields an excellent food. The peasants of Swabia preserve the leaves of cabbage, beet, radishes, salads, &c., for feeding their cattle. After throwing them into boiling-water, they heap them up in boxes, five or six feet square, which they construct of boards, fastened to four uprights; they then cover them with boards, on which they place stones. Every eighth day they add new layers of leaves, which they take care to salt. The whole becomes sour, and is preserved for winter use." [*Annales de l'Agriculture Francaise.*]

The use of straw for litter is noticed in the articles Litter and Stable; the proportioning and intermixing of it with fæces, in the article Farm-Yard Manure; the part which it plays as a fertilizer, in the article Manure; and the designs and principles of economizing it upon a farm, in the article Lease. "The stalks of wheat, barley, oats, rye," remarks Mr. Donaldson, "with occasional mixtures of spoiled hay, and the haulm of vetches, pease, and beans, being mixed with the fæces of the animals, much augment the bulk, and materially affect the quality of farm-yard manure. The constituent parts of those substances, as shown by chemical analysis, are principally earths and earthy and soluble salts, and in different proportions, which by entering into combinations with the animal and more easily soluble matters in the dung, retard the too rapid putrefaction of these substances, and constitute, with proper mixing and preparation, by far the most efficacious and durable fertilizer yet known." "All the various sorts of straw," says Sir John Sinclair, "answer the purposes of litter. Some farmers prefer the straw of rye, others that of wheat, which absorbs a great quantity of urine and moisture. The straw of pease and beans, when well broken by threshing, makes soft bedding; but, if well harvested, should be applied to feeding stock. Cattle, when soiled on clover, and other articles, or fed on turnips, are kept in a state of greater comfort when they have a sufficiency of litter. In the London markets, straw for litter is drawn straight in handsome trusses; and if threshed in mills, is less saleable, on account of its being more bruised, less sightly in the truss, and less durable in use, an object of some importance where straw is so dear; at the same time, it is probable, that the advantage of a softer bed for the horses would more than compensate for the additional expense. It is singular that the ancients were accustomed to break straw upon stones, for the purpose of rendering it more easily mixed with dung, sooner dissolved, and better adapted for litter; an operation which is now so effectually done by means of the threshing-mill. By some, littering stock with straw, has been considered to be unnecessary; others contend that all the straw of a farm ought to be exclusively appropriated to that purpose, and none of it applied to feeding stock: the truth seems to lie between these extremes. In Arabia, where the finest horses in the world are kept, no straw is used as litter. In Sweden and in Russia, instances are quoted of horses lying on boards, and of cattle standing and lying on a framing of wood-work, without any straw, or substitute for it, as bedding. Such plans, however, will not answer for horses, if exposed to severe labour, as, in that case, they require rest, in the most advantageous manner in which it can be given them. It may likewise be observed, that the principal advantage of littering, with a view to manure, arises from the straw absorbing the urine, for which purpose it is certainly well calculated. But wherever straw is scarce or dear, peat earth, or fine mould, might be advantageously employed for the mere absorption of urine. Other substitutes also might be used for litter, as fern, shellings of oats, or small shell sand, all of which have been found to answer. Straw, however, is the fittest article for this purpose, for, by fermentation, it is reduced into a gaseous state, and by moisture into a fluid state, and in either case, its whole substance is applicable as food for plants. The more of that article, therefore, that can be converted into manure, consistently with the other objects which require the farmer's attention, so much the more will his interest be promoted. Mr. Young was of opinion, that it was impossible to raise sufficient quantities of manure, more especially where soiling was practised, if any straw

were eaten; and the number of the best farmers in Norfolk maintain, that all straw should be used as litter, and trodden into dung, by animals feeding on much better food, as turnips, hay, or oil-cake. The principle is a good one; but it can never be generally carried into effect. All farms, as now cultivated, do not produce turnips, which is the best article to use for rotting straw, from the immense quantity of urine it produces; though there are many, in which that crop is now unknown, where a greater or lesser quantity of that valuable root might be raised. In regard to hay, or oil-cake, these articles are too expensive, and often too scarce, to make the use of them general; and, besides, such dry food furnishes little moisture to the dunghill, without which it cannot be so effectually converted into manure."

The proportion of straw produced on an acre or field or entire farm has been estimated roughly and averagely at twice the weight of the grain, —and more proximately as 100 lbs. of straw to 47 lbs. of grain in the case of winter wheat, 100 to 40 in the case of winter rye, 100 to 55 in the case of summer wheat, 100 to 45 in the case of summer rye, 100 to 63 in the case of oats, 100 to 66 in the case of barley, 100 to 43 in the case of pease, 100 to 48 in the case of vetches, and 100 to 42 in the case of beans; but it widely differs both in different varieties of one species in the same circumstances of soil and culture and season, and in the same variety of a species in different circumstances of soil and culture and season. In some leases, the straw of all the years of the tenure, and of all the crops raised, is required to be consumed wholly on the farm; and in others, it is allowed to be sold either according to the farmer's pleasure, or on condition of its being replaced on the farm by a compensating amount of some other fertilizer. In some, the straw of the last year's crops is reserved for the use of the landlord or of the incoming tenant without any remuneration; in others, it is reserved for the use of the landlord or of the incoming tenant upon a valuation according to the custom of the estate or of the county; and in others, it is allowed to be sold by auction or otherwise and removed to any place the purchaser pleases. When straw lies in a quadrangular compressed heap or rick, it may be sold by measure in the same manner as hay, 18 or 20 yards being reckoned for a ton according to the degree of the compression or comparative density; and when it lies in bundles, the weight of a small number of medium size may be ascertained by weighing them, and assumed as a datum for reckoning the weight of any great number or of the whole. Good straw suitable for the purposes of both fodder and litter has commonly ranged in market value between 20s. and 30s. per ton; wheat straw tied up is usually reckoned worth 10s. per ton more than wheat straw in a loose state; and the straw of barley and oats, when sweet and suitable for fodder, is commonly rated a few shillings per ton higher than loose wheat straw.

Straw, of various qualities and in various states, is used for mixing with argillaceous earth to make the walls and roofs of poor country houses,—for twisting into ropes to form drains and to serve other purposes,—for mixing with sea-weed to make a fertilizing compost, — for burning to yield potash from its ashes,—for bottoming chairs,—for stuffing horses' collars,—for manufacturing into paper,—for making straw mattresses,—for packing glass, china, and earthenware,—for manufacturing straw-hats, straw-bonnets, and several kinds of straw ornaments and trinkets,—and for a number of other purposes ranging from very coarse to very fine.

STRAWBERRY, — botanically *Fragaria*. A genus of hardy, evergreen, stoloniferous, fruiting herbs, of the rosaceous order. Two species grow wild in Britain; eleven have been introduced from other countries; and many permanent varieties, some natural and others the result of culture, occur in collections or in gardens. The appearance of all is similar; and that of the most common is so universally known as not to require any description. Three species are respectively red-flowered, yellow-flowered, and apetalous; and all the others are white-flowered. Most naturally bloom in April and May; but two or three naturally bloom at other periods; and varieties can be selected to yield a succession of fruit in the open air during seven or eight months of the year,—and to yield it with the aid of the forcing-house during the remaining four months. Most love a soil of rich loam; and all may be propagated from runners. Strawberry plants are favourites of most persons, and deserve to be high favourites of all,—their stoloniferous habit is so curious, their evergreen, low-spreading foliage so beautiful and refreshing to the eye, their elegant and charmingly scented blossoms so grateful to the sense of smell, and their handsome and brilliant fruit so salubrious and luscious and delightful to the palate. The popular name strawberry alludes to the ancient practice of placing layers of straw among the plants to prevent the fruit from being dashed by rain and polluted with the soil; and the botanical name fragaria alludes to the delicious fragrance of the fruit. But the fragrance, notwithstanding its great power and richness, soon dissipates after the fruit are gathered, and is so attenuated or decomposable as to escape every effort to catch and concentrate it by distillation; and the fruit, though popularly called berries, and though similar in appearance to some true berries, particularly to those of the bramble genus, are really not berries at all, but large, fleshy receptacles, having the seeds upon the exterior.

The common wood strawberry, *Fragaria vesca*, grows wild in the woods of Britain, and has long

been allowed a place in many a garden. It loves a soil of sandy loam, or a soil otherwise light, rich, and warm; and it may readily be raised from seeds, sown as soon as ripe, and cleared of pulp,—the seedlings to be finally bedded out in the following spring. Its fruit is red and small, and has a sweet tartish taste. A variety of it with white fruit, commonly called the white wood strawberry, ripens a little later in the season, and has a quicker and to some persons more grateful flavour, but is generally less prolific. Another variety with green fruit, commonly called the green strawberry, the green pine strawberry, or the pine-apple strawberry, has a small, firm, much-admired fruit of high, rich, peculiar flavour. It is late in ripening, and requires a dry soil and an open situation, and may be grown at such small distances as six inches from plant to plant, and either allowed to run together or kept separate.

The hautbois or hautboy or taller strawberry, *Fragaria elatior*, though not indigenous in Britain, grows wild in some of our woods, and is a wide-spread native of other lands, and probably was introduced to Britain from both the old world and the new. It is supposed to have got its name from being found wild in the high woods of Bohemia; and it was long a chief favourite among the cultivated strawberries of British gardens. Some of its flowers are occasionally or perhaps constantly defective, or, in popular phrase, "blind;" and the plant, though belonging to the Linnæan class Icosandria, has some claims to be considered diœcious. Its fruit are middle-sized, round, and somewhat depressed, —dark red when exposed to the sun, but otherwise dull white; and the pulp is substantial, greenish, very sweet, and has an agreeable musky flavour. This species loves a light, sandy soil, kept moderately rich by biennial applications of manure; and when it is wished to produce large crops without fastidious regard to quality, it may be allowed to overrun the whole surface of the ground, and it will then maintain itself in vigour and yield a prolific produce for a series of years, with the simple aid of an occasional top-dressing of old hot-bed dung.—A variety of it called the prolific hautbois strawberry, not only bears well at the usual season, but sometimes yields a second crop in autumn. The fruit is large, dark red, swollen at the base, and contracted toward the point; and the pulp is solid, greenish, and of a fine musky flavour. This variety, however, is in its prime in the second year, and becomes exhausted in the third.—Two other varieties, called the globe and the flat, differ from the normal plant principally in the shape of the fruit.

The Chili strawberry, *Fragaria chilensis*, was introduced to Britain in 1727. It has large, thick, hairy leaves, on very strong hairy footstalks; and carries large and frequently deformed flowers in May and June; and is a vigorous grower, but an uncertain bearer. Its fruit are very large, irregularly shaped, often deformed, and of a brownish white colour, with a little red on the sun-exposed side; and the pulp is white, very firm, hollow at the centre, and of a rather flat flavour, especially when quite ripe. When this plant grows on strong land, in a shady situation, and is allowed to run together, its produce is sometimes tolerably bulky, and has the recommendation of being ripe for use about the time the crops of most other kinds of strawberries have been all consumed.

Wilmot's superb strawberry resembles the Chili in habit, but excels it in size of fruit and in certainty of bearing, and is one of the finest varieties in cultivation. The fruit is irregular in shape, has large prominences on two or three sides, attains a weight under good culture of upwards of an ounce, and sometimes of two ounces, and has a shining red colour, somewhat shaded with a deeper tint; and the pulp is coloured, firm, and almost solid, and has an excellent flavour. The stems which carry the fruit are strong, and in general clustered; and some of them are benefited by being tied up. New plantations of this strawberry should be made every second year; the soil chosen for it should be a fresh soft loam; no strong manure should be applied, and only occasional top-dressings; and the runners should be frequently cleared away to such an extent as to leave merely a sufficient number to form new plantations.

The scarlet Virginian strawberry, *Fragaria virginiana*, was introduced from North America in 1629; and long possessed a fame in British gardens similar to the hautbois; and is still one of the most generally suitable for cultivation whether in the open ground or by forcing. It is a good bearer; and loves a soil of rich loam; and ripens in the south and centre of England in the latter part or toward the end of May. The fruit is middle-sized, somewhat pointed, and of a bright scarlet colour; and the pulp is firm, and has a fine flavour.

The Duke of Kent's scarlet strawberry, or the Austrian scarlet strawberry, is a prolific bearer, and ripens in the south and centre of England about the middle of May, and is accelerated in ripening by being planted on a sloping bank or sloping border with a warm exposure. The fruit is less than middle-sized, nearly spherical, and of a scarlet colour; and the pulp is solid, juicy, and highly flavoured. New plantations should be made in such order as to allow all plants to be uprooted and thrown away after their third year; the soil should be a mild, kindly loam, not overdosed with manure; and the distances between the plants should be 12 inches from row to row and 9 from plant to plant.

The Lewisham or cluster scarlet strawberry is a prolific bearer, and produces a succession of fruit through a considerable period. The fruit resists the bad effects of wet weather better than

that of most other varieties, but requires to be perfectly ripe before being gathered for use. It grows in clusters, and is round, rather small, and of a dark red colour; and the pulp is firm.

The Grove-End scarlet strawberry ripens a little later than the scarlet Virginian, and is a good successor to it, and bears prolifically, and is well deserving of cultivation. The fruit are rather above the middle size, well shaped, and of a bright red colour; and the pulp is juicy and rather firm, and has a flavour similar to that of the Virginian.

The new Southampton scarlet strawberry, or Godfrey's new scarlet strawberry, is an abundant bearer, and well worthy of cultivation, and thrives best in a rather heavy rich loam. The fruit is middle-sized, of a dark red colour, and eminently suitable for jam; and the pulp is firm, very juicy, and of a rich vinous flavour.

Wilmot's late scarlet strawberry is a rather inferior bearer, and not at all remarkable for aggregate excellence; but it yields a long succession of large fruit, and on that account deserves a place in a large establishment. The fruit has a light red colour; and the pulp is firm, with a small cavity in the centre, and has only a middle-rate flavour.—Knight's large scarlet strawberry resembles Wilmot's late scarlet in at once size, colour, and general qualities.

The Roseberry strawberry bears well in the open ground, and is peculiarly suitable for forcing. The plant has a peculiar habit, and carries its fruit near the ground; the foliage is short and compact; the fruit is large, a little pointed, and of a pale scarlet colour; and the pulp is substantial and juicy, and has a fine pleasant flavour. Some soft substances, such as straw or lawn-grass, should be spread beneath the foliage before the plants come into flower.

The Pitmaston black strawberry is a late ripener, and produces a convenient and very desirable succession after the earlier varieties, and well deserves a place in every considerable garden. The fruit is somewhat oval, rather above the middle size, and of a deep red colour both without and within; and the pulp is firm, juicy, and finely flavoured. The soil most suitable is a rich hazel loam; and it should be enriched only with slight top dressings.

Keen's seedling strawberry is prolific, and produces its fruit in clusters, and is well adapted for forcing, and yields fine crops, with comparatively little expense or trouble, during April and May. The fruit is large, of a dark scarlet colour, and variously shaped, but chiefly spherical; and can be carried to a distance with less risk of injury than the fruit of most other varieties; and the pulp is substantial, coloured, and of a rich flavour. The plant is a vigorous grower, and, either on beds or in quarters, requires ample room; and the fruit grows in clusters, which need to be tied up. A variety called Keen's imperial strawberry also possesses good properties, yet is inferior to Keen's seedling.

The old black pine strawberry is one of the best of a considerable class of varieties called pine strawberries. It is very prolific, and requires more space for every plant than the old scarlet Virginian. The fruit is rather larger than middle size, generally pine-shaped or conical, but sometimes globular, and always of a deep red colour; and the pulp is firm, coloured, juicy, melting, and of a rich flavour.

The Downton strawberry is a peculiar and very splendid variety. The leaves have a shining green colour, and stand on very short foot-stalks; the fruit is large, various in shape, and of a deep red colour; and the pulp is firm, coloured, melting, and of a high and delicious flavour. The plant is prolific in the first and the second years, but becomes comparatively barren, though of increased size, in the third; so that it must not be kept longer than two years. Comparatively few runners are produced; and they must be well cared for, and allowed to remain where they grow till they become sufficiently strong for removal to their final destination. The trusses of fruit grow on long foot-stalks, and are peculiarly liable to sprawl on the ground, and to become damaged or destroyed by the weather and slugs and the soil; and they should be propped or tied up with short sticks. This variety thrives best on a moderately light and rather dry loam.

The British Queen strawberry is a somewhat recent and very remarkable variety. It is an abundant bearer and a very free grower, and produces large and beautiful fruit. "As to size," said a critical notice of it at the time when it began to challenge the attention of cultivators, "we have measured many which averaged six inches in girth; as to weight, we picked out 17 that weighed 16 ounces; as to productiveness, we have found several stems a foot high bearing from 5 to 7 strawberries,—and in two cases there were 10 and 11 on a stem; finally, as to quality, the variety is inferior to the old pine, but is better than Keen's seedling, having more flavour. It is, in fact, a very delicate, agreeable variety, without the insipidity and wooliness of the coarse and large strawberries. These are, we believe, its true characters. The next question is, how far it has claims to be regarded new? The only variety with which it can be compared is the Downton, itself one of our best strawberries, and sometimes nearly as large as this. We, however, do not think it the same; it has much less acidity, and does not require to be almost black before it is eaten; on the contrary, its greatest excellence seems to be when it is of a clear bright rose colour; nor is its flesh so firm as that of the Downton."

The old Carolina strawberry is a well known and much esteemed variety. It is a good bearer and a strong grower; and loves a rich fertile loam, rather moist than dry; and requires to

have its clusters of fruit tied up. The fruit is large, and of a scarlet colour, and various in shape,—sometimes conical and sometimes globular; and the pulp is coloured and juicy, and has a fine vinous flavour.

The red alpine strawberry is said to have been brought to Britain from the north of Italy; and is easily and frequently raised from seed. It is capable of bearing fruit through a long succession; but it cannot compare in quality with any of the most esteemed summer-bearing varieties; and it is employed principally for producing in autumn after all these varieties have ceased to bear. It is commonly planted in a north border, or other comparatively cool and shaded situation, and allowed to overrun the ground. Seed for it should be taken from the ripest and strongest autumn fruit, washed free from pulp, dried, and kept dry till about the middle of March, and then sown; and as soon as the young plants can be handled, they should be transplanted into beds.—The white alpine strawberry is a subvariety of the preceding, but has rather larger and less acidulous fruit, and does not produce so late in autumn, and is propagated, not from seeds, but from runners.

Many other kinds of strawberries might be named, either species, varieties, or subvarieties; but some are interesting more as curiosities than as useful plants, and few are comparable in value or excellence with the greater part of those we have described. Among the more remarkable are the one-leaved, introduced to Britain about 75 years ago, and blooming in May and June; the Canadian, a tall kind from North America, blooming in April and May; the hill green pine, introduced about 80 years ago from Germany, and blooming from April till the end of autumn; the plane-like, a red-flowered kind from North America, blooming from April till June; the Bresling, from France, blooming from April till June; the great-flowered pine, introduced about 90 years ago from Surinam, and blooming in April and May; the Indian, a yellow-flowered, peculiarly creeping kind, introduced about 45 years ago from India, and blooming from May till toward the end of autumn; the Buenos-Ayrean, an apetalous and very tall kind, blooming from April till June; Myatt's pine, producing a very beautiful and very richly flavoured fruit of a glowing vermilion colour, but so surpassingly intractable as almost to defy cultivation; Knight's Elton, bearing late in the season, and producing a large fruit, beautiful to the eye, and, when perfectly ripe, of very full, peculiarly grateful flavour, tending to acid; the Bostock,—Bishop's orange,—Wilmot's cockscomb,—and a great number of recent seedlings and hybrids.

Instructions for the cultivation of the strawberry might be spun out to a vast length, and rendered exceedingly diversified by incorporating with them the theories and rules of the most eminent horticulturists, and by adapting them to differences in the tastes and habits of the plants, in the soil and exposure of situations, and in the seasons and objects of respectively out-of-door and in-door cultivation. But we must necessarily content ourselves with showing only the salient points; and these may refer to the selection and management of runners,—to the preparing and planting of annual beds,—to the making and managing of triennial plantations,—to the general culture of all sorts of open-ground crops,—and to the best method of forcing.

In September, when the weather is mild, the ground is usually moist, the sunshine continues to be sufficiently genial, and all things conspire to render the preparation of strawberry-beds more facile and efficient than in any other month in the year, a stock of young plants will generally be found ready matured by the natural processes of growth, in the strawberry plantations of the preceding year or two years, for the immediate uses of the planter. Each young plant, in the case of by far the greater number of the good varieties, may be seen occupying a space equal to that of a full-sized saucer, with from four to six healthy leaves, around a bold, prominent, firm, central bud, and generally at the end of the stolon or runner which proceeds from the parent stock; and every such plant—provided that a certainty exists that the parent stock is fruitful—may be removed direct to a final destination in a new bed. The caution, however, requires to be borne in mind, that many of the largest and most beautiful parent plants are quite barren of fruit and eminently productive of runners, and that most parent plants which furnish the best fruit, and are in the most prolific state for bearing it, produce comparatively few runners.—But careful and economical cultivators, in addition to making sure work of the prolificity of their young plants, adopt measures to promote their vigour and to get them early ready. "The strongest are chosen after they have formed their own roots, which they readily do if lying close to the ground. And as it is an advantage to get them off the stools as soon and as well rooted as possible, some cultivators make small pits, or plunge small pots filled with fresh cucumber compost, on which the best runners are laid and pegged down, having their points pinched off. Here they soon make strong roots, and ready to be taken off to be planted in the open ground; or if required for forcing, those rooted in small pots may be shifted into larger, and put away in a proper shady place till they are wanted to go into the forcing house, strawberry pit, or hotbed."

The general rules for making prime annual beds of most of the good and the first-rate varieties of strawberry, is to prepare the ground three weeks before it is wanted,—to trench two feet deep, without bringing any of the lower soil to the surface, or with simply digging the lower spit, and turning and effectually pulverizing the

upper one,—to apply a moderate dose of rather recent stable dung on the top of the lower spit,—to choose a good, free, turfy, velvety loam,—and to make the plantation during a moist state of the soil, in the early part of September. Some eminently successful cultivators, however, make their annual beds a month or so earlier than we recommend; and the Rev. T. Garnier, one of these, says in the Horticultural Society's Transactions: "Early in August, or as soon as the gatherings are over, I destroy all my beds, and proceed immediately to trench, form, and manure them to receive the plants for the crop of the ensuing year, taking care to select for that purpose the strongest and best-rooted runners from the old rejected plants. If at this season the weather should be particularly hot, and the surface of the ground much parched, I defer the operations of preparing my beds and planting them till the ground is moistened by rain. Such is the simple mode of treatment which I have adopted for three successive years; and I have invariably obtained upon the same spot a great produce of beautiful fruit, superior to that of every garden of the neighbourhood. Depth of soil I have found absolutely necessary for the growth and production of fine strawberries; and when this is not to be obtained, it is useless, in my opinion, to plant many of the best varieties. It is not generally known, but I have ascertained the fact, that most strawberries generate roots, and strike them into the ground nearly two feet in the course of one season. The pine and roseberry succeed better than any other in stiff and shallow soils, but they should always lie in an open situation, and not, as is too commonly the practice, in shady and neglected parts of the garden."

In the triennial course of making and managing strawberry plantations, the preparing and manuring of the ground are the same as in the annual course. The planting may be done either in the form of single border rows, or in that of plots. If it be done in the former, the row should have an open space of from 12 to 18 inches of clear ground on each side of it; and the plants should be set by the trowel one foot asunder, securing the roots firmly in the soil, the fibres being expanded so as to be covered with earth in every part. If beds be adopted, the same distances are to be maintained, but the rows must be two feet asunder with alleys of approach by the sides laid with coal ashes. Water must be freely given from the rose of a water-pot in the evenings, till the plants stand firm and erect under the full sun; and afterwards the ground should be flat hoed, to bring the earth close around the base of each root, and to obliterate the smallest weed. In this system every blossom shown in the following spring is pinched off, not one plant being suffered to bear fruit in the first year; so that it will be proper to leave a few old beds to bear while the plan is in progress. The runners as they appear are cut away, and weeds are regularly destroyed. Throw a little fresh loam and a little reduced manure, mixed in equal proportions, along the rows on each side to enrich the ground while it protects the plants during winter; and in March take off the dead leaves and fork the spaces. This is to be the practice of each year. Suffer all the plants to bear in the second spring, and the crop will be in perfection: cut off runners and observe the other directions. In the third year the crop will be very fine; but now the end of the course is come, and the plants are to be rooted up. Therefore, to perpetuate the succession, new beds or rows must be begun every year, so that there shall always be a set of plants advancing through one or other of the stages. To provide new plants, a sufficiency of the finest runners of the third year's plants must be allowed to fix themselves in the ground of the intervening spaces, keeping them apart from the old plants to benefit by full exposure to air and sun.

A succession of fruit from plants in the open ground, during eight months of the year, or at the least during most of summer and a large part of autumn, is obtained partly by selecting varieties which naturally bloom and bear successively to one another,—partly by planting each in various aspects, as east, north, and south,—and partly by pinching off all the first flowers of early blooming varieties, so as to induce the natural bloom of the following spring to appear and fructify in the present autumn. All strawberry plants, howsoever situated, and whensoever expected or intended to bear, must be periodically or occasionally refreshed with water so as never to be allowed to become dry during the whole period from their beginning to show flowers till their ceasing to ripen fruit. All the varieties which are most liable to be dashed and sullied by heavy rains and plashy ground, must either be tied up or propped or otherwise protected by some artificial contrivance. One method is to lay slates or plain tiles along both sides of each row of plants,—and this not only keeps the fruit clean, but accelerates its ripening and improves its flavour; and another and more expensive and somewhat aristocratic method is to construct the strawberry beds of brick-work, in the form of a ridge of graduated steps, with interstices for the reception of the plants, and with a channel along the ridge for such an occasional or periodical application of water as will keep the soil beneath the bricks in the requisite state of moistness.

When plants intended for forcing have been well established in small pots, and shifted into larger, they should be removed to some suitable place in the open garden, and plunged in the earth to the rims, and supplied with water as often as necessary to keep them in a continually growing state. In November, they may undergo another shift; and at any time in January, from the ear-

liest day onward, they may be removed to a mild bottom heat of a fluid dung-pit, or old melon or cucumber bed, fresh lined,—the pots plunged,—the plants within a foot of the glass,—and a large portion of air admitted at all favourable opportunities,—the lights closed and covered with mats or straw shutters at night. They may remain in this situation, in an atmospheric heat of from 50° to 60° Fahrenheit, till the fruit be set; and then they may be removed to the stove to ripen,—any number of pots at a time, according to circumstances; and in this way, by a proper succession of removals, they will afford a constant supply of fruit from the beginning of March till the beginning of June,—and will do so though they should all be plants of Keen's seedling, or of any other one eminently good and suitable variety. During all the month of June, a supply may be obtained from Keen's seedling, the Grove-End, the roseberry, and other scarlets, grown on a south border of the open ground or at the foot of a wall; during the latter half of June and the former half of July, from the several varieties of pine, hautboy, and other common kinds, grown in the open quarters of the garden; during the latter half of July and the former half of August, from Keen's seedling, the Downton, and the pine, grown on a border facing the north, shaded by a wall; during the latter half of August and the whole of September, from Keen's seedling, transplanted from pots immediately after forcing, and grown on a well manured south border; during all October and the former half of November, from red and white alpines, raised in the preceding January from seed, and grown on a well manured south border; and during the latter half of November and the whole of December, from red and white alpines, raised from seed in the preceding January, and grown and ripened in pots in a heat of from 60° to 70° Fahrenheit. The seed of the alpines, when thus used, must be sown in shallow pans or boxes, with light rich mould; the pans or boxes must be placed in a stove or hotbed till about 6 or 7 weeks after sowing; the plantlets, at this period, must be pricked out, and set on a slight hotbed, about 3 inches apart, and protected with a frame and lights; and they must afterwards be well supplied with air and water, and defended with sufficient covering to protect them from all frost and severe weather till May; and in this month, part may be planted out for fruiting in the open ground, and the rest potted, one plant in a pot, to be kept in a growing state through the summer, and shifted into larger pots in August, and forced into fruiting in the closing months of the year. A very few varieties and a somewhat limited range of contrivances are thus sufficient for obtaining a constant supply of fruit during ten months of the year; and if all the naturally successional varieties were brought into play, and all the arts of the gardener in the open ground and in the forcing structures made to tell upon them, the supply might be ample and diversified to satiety,—but, of course, would be aristocratically costly.—*Rogers's Fruit Cultivator.—Philip's Fruits.—Haynes's Treatise on the Strawberry, Raspberry, and Gooseberry.—Paxton's Botanical Dictionary.—Loudon's Works.—The Transactions of the Horticultural Society.—The Gardener's Chronicle.—The Gardener's Gazette.—The Magazine of Domestic Economy.—Miller's Gardener's Dictionary.—The Survey of Mid-Lothian.*

STRAWBERRY-BLITE. See BLITE.

STRAWBERRY-TREE. See ARBUTUS.

STRAW-CUTTER. See CHAFF-CUTTER.

STRAW-CUTTING. See STRAW, FODDER, and CHAFF-CUTTER.

STRAW-HOUSE. See BARN and FARM-BUILDINGS.

STRAW-RACK. See STABLE.

STREET-MANURE. See POLICE MANURE and SEWERAGE.

STRELITZIA. A genus of ornamental, Cape-of-Good-Hope, evergreen, herbaceous plants, of the banana family. The queen's species, *S. reginæ,* was the earliest known to botanists, and the earliest introduced to Britain; and is still the most generally known, and may serve as an excellent specimen of the whole genus. It was discovered by Sir Joseph Banks, when acting as naturalist to the first expedition under Captain Cook; and was named in honour of the queen of England, a princess of the house of Mecklenburg-Strelitz; and was sent to Britain in 1773. It has a habit somewhat similar to that of a Calla, and commonly attains a height of about 6 feet. A vigorous plant of it may have 16 or 18 thrifty leaves about 3 feet high, and three strong flower stems, with their crowned heads of flowers towering above them. Each stem has three or four large flowers, which open successively from a curious spathe-like calyx, and stand up like a crest of gold; the petals have a rich orange yellow colour, and surround three broad stamens of the deepest purple; and a drop of pure nectar distils from each flower, and stands on the exterior like a brilliant gem. The plant commonly blooms in March and April, but can be urged forward to bloom in January; and it continues in bloom upwards of a month. Most authorities recommend for it a light sandy loam; but some gardeners have found it to succeed best in a rather heavy, rich, black loam, kept pretty moist. Of seven other species which have been introduced to Britain, one, the august, is white-flowered, and all the others are yellow-flowered; two, the august and the ovate-leaved, are respectively about 18 and 8 feet high, and all the others are about 5 or 6 feet high; three, the august, the ovate-leaved, and the mealy-stalked, bloom in February and March, and the others do not bloom till May; and two, the august and the ovate-leaved, as also the queen's, are propagated from suckers, and all the others are propagated

from seeds. All require a pretty high temperature, and make a very brilliant appearance.

STRENGTH OF MATERIALS. The force with which the particles of a solid body resist the forces that tend to separate them, and which constitutes their strength, may be found, in particular cases, by experiment. If the experiments be multiplied, both in respect to the species of substances, and to the size and circumstances under which portions of a given substance are employed, a general law might be finally obtained whence algebraic expressions of the relation between the strength, the dimensions, and the material, might be deduced. Or we may, by assuming an hypothesis to represent the probable manner in which bodies are made up, deduce from the general formulæ, which, applied to cases that occur in practice, will be sufficient, in almost every instance, to represent the phenomena.

Galileo was the author of the hypothesis that is most generally employed by writers on mechanics, and which will suffice in all usual cases. He assumes that all solid bodies are composed of a great number of parallel and equal fibres, perfectly inflexible and inextensible; that when they break, the several fibres give way in succession, and the body turns upon the fibre or fibres that are the last to give way, as upon a hinge. Leibnitz observing the flexure that takes place in bodies before they break, assumed as the basis of his hypothesis, the fact, that every body admits, before it breaks, of a certain degree of extension: the fibres, therefore, are both extensible and flexible; and he inferred that the strength of each fibre, instead of being equal, varied with its quantity of extension, or was proportioned to its distance from the fixed point around which the beam is supposed to turn. The hypothesis of Galileo has been recently extended by Barlow, who has, by introducing the circumstance of the occurrence of a flexure before the beam breaks, been enabled to explain all the cases which appeared, by a comparison of the hypothesis with experiment, to be anomalous.

The force which tends to destroy the aggregation of the particles of a solid body, may act in four different manners.

(1.) It may tend to tear the body asunder by exerting an action in the direction of its fibres.

(2.) It may tend to break the body across, by a transverse strain, exerted either perpendicularly or obliquely to the direction of its fibres.

(3.) It may tend to crush the body.

(4.) It may tend to separate the particles by means of torsion, twisting or wrenching the body, by an action in a plane perpendicular to its axis.

The resistance which bodies oppose to a force acting in the first of these modes, is called *the Absolute Strength.* In fibrous bodies, it is different, according as the force is applied in the direction of the fibre, or at right angles to it: for although by hypothesis we should conceive fibres to exist, even in the transverse direction, yet, in nature, none such are found; and the aggregation is far more easily destroyed in the latter case than in the former. The resistance to a fracture across the body, is called its *Respective Strength;* and we may call the resistance to a twisting force, *the Strength of Torsion.*

It needs no reasoning to show that the measure of the strength, even in the same body, will be different in each of these different cases; and such is the difference in the manner in which the particles of bodies of different natures are united, that there can be no general law that will represent the relations of these four species of resistance. But in conformity with our hypothesis, it will be obvious that, in all the several cases, the resistance to fracture will vary with the number of fibres, which, in homogeneous bodies, will depend upon the area of their sections. It must also depend upon the manner in which the force acts to break the body.

I. *Of the Absolute Strength of Materials.* When the strain is exerted in the direction of the fibres, the force that tends to break a body will be directly opposed to its force of aggregation, and the resistance must depend upon the cohesive force of each fibre, and upon their number, but upon no other circumstance.

The most valuable experiments that we have of this sort, are those of Barlow, upon wood. These were made upon cylindrical rods, and the strength, deduced for an element of the area of a square inch. The results are contained in the second of the following tables. The first table has been compiled from various other sources.

TABLE I.

Absolute Strength of the Metals.

Cast Steel,	140,000 lbs.
Gold, (*according to Morveau,*)	80,000
Wrought Iron, (Swedish,)	72,000
do. (English,)	56,000
do. do. in the form of chains,	48,000
Bronze, (Gun Metal,)	36,000
Wrought Copper,	33,000
Cast do.	19,000
Brass,	17,000
Tin,	4,700
Lead,	1,800

TABLE II.

Absolute Strength of different kinds of Wood drawn in the direction of their fibres.

Boxwood,	20,000 lbs.
Ash,	17,000
Teak,	15,000
Norway Fir,	12,000
Beech,	11,500
Canada Oak,	11,400
Russia Fir,	10,700
Pitch Pine,	10,400
English Oak,	10,000
American White Pine,	9,900
Pear Tree,	9,800
Mahogany,	8,000
Elm,	5,800

TABLE III.

Absolute cohesive Strength of Wood drawn in a direction at right angles to the fibres.

Teak,	818 lbs.
American White Pine,	757
Norway Fir,	648
Beech,	615
English Oak,	598
Canada Oak,	588
Pitch Pine,	588
Elm,	509
Ash,	359

II. *Of the Respective Strength of Materials.* To apply the hypothesis of Galileo to the case of a transverse strain, we shall suppose in the first place, the substance to have the form of a prismatic beam, that it is firmly inserted at one end into a fixed support, lies in a horizontal position, and is acted upon by a weight that presses at the end that is not fixed; that the fracture takes place at the point of support, beginning at the upper side, on which the weight presses, and terminating at the other. The beam then, its fibres being by hypothesis inflexible and inextensible, will turn around the latter point in a vertical plane. At the instant of fracture, the two forces that act are in equilibrio with each other, their respective moments of rotation must be therefore equal.

When a beam, lying in a horizontal position, rests upon two props, and is broken by a weight placed at an equal distance from the two props, we may consider the laws of its strength as included in the general case of a beam supported at one end only; for if, according to the hypothesis, it break without bending, we may conceive it to be formed of two beams, each inserted in a firm support at the place of fracture, and acted upon at each end by a force equal to half the weight that just breaks it, but which is directed upwards instead of downwards. This force, which is equal to half the weight, will act at a distance which is equal to half the length; its effort is therefore equal to no more than a fourth part of the effort of the same weight, applied to the same beam, if supported at one end only; and as this effort must be just equal, at the instant of breaking, to the transverse strength of the beam, the latter will be four times as strong as when supported at one end only.

In the case of a beam lying horizontally, and firmly fixed at each end, the resistance will be equal to that of a single beam supported by two props, added to those of two beams fixed at one end only; for it is obvious, that three fractures must be produced, one in the middle, and one at each end; at the first, the resistance will be equal to that of the supported beam, or four times as great as that of the same beam, if supported at one end only. The resistance in each of the latter cases, will be that of a beam of half the length fixed at one end only, or one fourth of the last resistance; the whole resistance will therefore be six times as great as that of the same beam when fixed at one end only.

When the weight that tends to break a beam is not accumulated at a single point, but is uniformly distributed over its whole length; its effort is diminished to the half of what it exerts, when, in the case of a beam fixed at one end, it acts at the opposite extremity; or when, in the case of a beam supported or fixed at both ends, it acts in the middle.

We have hitherto omitted the action of the weight of the beam itself. In small beams indeed, their own weights are of little importance, and need hardly be taken into account in the experiments; but in large beams this is not the case, as may easily be seen. The weight which breaks a beam is made up of its own weight, and the weight which is applied for the purpose: the former acts at the centre of gravity of the beam, which in prismatic beams is in the middle of their length.

We shall now recapitulate the results of our hypothesis, and state what discrepancies have been observed between them, and the inferences from actual experiment.

(1.) In any prismatic beam whatsoever, the strength is directly proportioned, to the area of its section, and to the distance of its centre of gravity from the point where the fracture terminates; and inversely, to the length of the beam.

(2.) The strengths of beams lying in a horizontal position, when fixed at one end only; when supported by a prop at each end; and when firmly fixed at both ends, are as the numbers 1 : 4 : 6,—that is to say, a beam firmly fixed at both ends, is six times, a beam merely supported at both ends, four times as strong as when it is fixed at one end only.

These several inferences from the hypothesis agree within all usual limits, with the results of experiments. The discrepancies are, that the strengths increase in a ratio a little greater than the square of the depth, in rectangular beams; and decrease rather more rapidly than the inverse ratio of the length.

The second of the above propositions admits of the following cases :—

(*a*) In beams of the same material, with equal and similar sections and unequal lengths, the strengths are inversely proportioned to the lengths.

The lengths being equal :

(*b*) In rectangular beams of the same materials the strengths are proportioned to the product of the breadth by the square of the depth ;

(*c*) In square beams, the strengths are proportioned to the cubes of the sides of the square sections ;

(*d*) In solid cylindric beams, the strengths are proportioned to the cubes of the radii ;

(*e*) In hollow cylindric beams, having the same quantities of material distributed around cylin-

dric cavities of different diameters, the strengths are directly as the diameters.

(3.) Large beams are weaker in proportion than small ones, for their own weight constitutes a part of the force that tends to break them; and in similar solid bodies, the stress growing out of their own weight increases as the cubes of their homologous dimensions, while the strength only increases with the squares.

We see from this, that models may be strong, and capable of bearing a stress far beyond any that can be applied to them; yet that machines constructed exactly similar to them in proportion and of like materials, but of increased dimensions, may become too weak to bear even their own weight; that there must be a limit to the size and extent of any structures that can be erected by the hand of man; and that a similar limit exists even in the works of nature. Thus, in organic bodies, mountains, hills, trees, the size they can attain, without risk of disintegration, is restricted within certain bounds. In the animal creation, the same principle applies, and the limit is sooner reached.

Our theory would show that when a body becomes weak in consequence of an increase of length, strength may at first be added by increasing its breadth, and still more by increasing its thickness, the length remaining constant. Here, however, the weight is increased in a greater ratio than the length, and finally becomes excessive. The same quantity of material may assume a stronger form by being fashioned into a hollow tube; yet here again a limit is reached when the circumference of the tube becomes so thin as to be liable to be crushed by the forces that act upon it.

In animals we find that the smaller classes have bones far more slender in proportion than those of the larger kinds. Their muscles are far less thick in proportion to their length; and their masses are diminished in a proportion much more rapid than that of the cubes of their similar dimensions. We find small animals capable of lifting weights greater in proportion to those of their own bodies, than larger animals can; and in spite of this additional effort, they are enabled to continue their exertions for a longer period without fatigue. To obtain the greatest possible strength with the least possible weight, the bones of animals have the form of hollow tubes, as have the quills and feathers of birds. In the vegetable kingdom, we find trees and plants made up of bundles of hollow tubes; and in those where great strength and comparative lightness are necessary, these are again arranged so as to form a hollow cylinder; as, for instance, in the whole family of the gramina.

(4.) When beams are in an inclined position, their strength, which we shall call F, becomes $F = W \cos. i$. This deduction from the hypothesis is true in practice, so long as the beam does not bend under the effort of the weight applied to break it.

(5.) When the pressure, instead of acting upon a single point, at the extremity of a beam fixed at one end, or in the middle of a beam supported or fixed at both ends, is equally distributed throughout the whole beam, twice the weight will be required to break it.

As far as we have recited the results of the hypothesis, they agree in all useful cases with the deductions from experiment. But some of the rules, deduced from the hypothesis, do not coincide with what occurs in practice.

Thus it has been shown that there is a difference in the strength of triangular beams, according to their position, with an edge or a face uppermost; and that this difference follows different laws, according to the manner in which the beam is supported. Experiment absolutely contradicts this; for in neither of the three different positions in which beams have been tried, has any important difference been found in the strength of a triangular beam, when placed with an edge, or with a face uppermost.

So also, hollow cylindric beams have not been found stronger, when the cavity has been nearer to the side where the fracture terminates, as they ought to be in conformity with hypothesis; neither is a square beam stronger when its diagonal is vertical.

These remarkable discrepancies, together with the less important ones that have been noted in the preceding section, arise from an omission in the hypothesis; this does not take into account the elasticity and consequent flexure which materials undergo before they actually break.

Table of the respective strength of various substances.

Metals.

Wrought iron, Swedish,	22,000 lbs.
do. English,	18,000 lbs.
Cast iron,	16,000 lbs.

Wood.

Teak,	4,900 lbs.
Ash,	4,050
Canada Oak,	3,500
English Oak,	3,350
Pitch Pine,	3,250
Beech,	3,100
Norway Fir,	2,950
American White Pine,	2,200
Elm,	1,013

We are without any good experiments on the respective strength of stone. It would, however, appear from some experiments of Gauthey, that, in soft freestone,

$$s = 68\ 7 \text{ lbs.}$$

In hard freestone,

$$s = 72{\cdot}75 \text{ lbs.}$$

And from some experiments recorded by Barlow, that in brick,

$$s = 64 \text{ lbs.}$$

This would make the respective strength of stone and brick far beneath that of wood or iron.

III. *Of the Resistance of Bodies to a Force exerted to crush them.*—The resistance of bodies to forces that act to crush them, would, at first sight, appear to follow the same law with the absolute strength; that is to say,—it must be proportioned to the area of the body, and the force of aggregation of its particles. Experiment, however, shows, that the thickness of the substance has an important influence on the pressure it is capable of bearing, without being crushed. In the first place, it is found that very thin plates are readily crushed; their resistance next increases with the thickness, until it reach a maximum; and finally decreases slowly, with a farther increase of thickness. This branch of the subject has been illustrated under the head PRESSURE.

In bodies whose sections are similar, it may be inferred that the resistance to a force exerted to crush them, is proportioned directly to the cubes of the homologous dimensions of the sections, and inversely to the squares of their lengths. The most complete set of experiments that we have upon the variation in the strength of columns of different lengths, are those of Muschenbrook, and they correspond closely with the above theory. The subject, however, has not been so fully tested as to authorize us to receive any theory with implicit confidence. We shall, in consequence, give the absolute results of experiments, in the terms of the weights and dimensions of the original record, without attempting to reduce them to a conventional unit.

TABLE.

Experiments made by Rondelet, on the Resistance of different species of Stone in cubic blocks, of the size of 5 centimetres in each dimension.

	Spec. Gravity.	Crushing Weight. Kilogrammes.
Swedish Basalt, . .	3·065	47 809
Basalt of Auvergne, No. 1,	3·014	44·250
Do. No. 2,	2·884	51·945
Do. No. 3,	2·756	28·858
Porphyry, . . .	2·798	50·021
Green Granite (Vosges), No. 1,	2·854	15·487
Grey do. (Brittany),	2·737	16·353
Granite (Vosges), No. 2, .	2·664	20·482
Granite (Normandy), .	2·662	17·555
Granite (Champ du Boul),	2·643	20·441
Granite (Oriental Rose), .	2·662	22·004
Black Marble (Flanders), .	2·721	19·719
White Veined Marble, .	2·701	7·455
White Statuary Marble, .	2·695	8·176

Experiments made at the same time upon cubes of stone, whose sides varied from 3 to 6 centimetres, showed that the strengths varied nearly in proportion to the areas of their bases, and were not influenced by the thickness. This corresponds to the law of absolute strength, and differs from that we have given for the resistance to crushing. On the other hand, when cubes of the same size were placed one upon another, a diminution in the resistance was found that does not differ much from the latter law.

By experiments made by Rennie, on the resistance of cast iron to pressure, it was found that the maximum strength was reached at thicknesses of from $\frac{3}{8}$ths to $\frac{1}{2}$ an inch, and that a prism a quarter of an inch square, and half an inch in depth, was crushed by 10,000 lbs.

A cube of cast copper, $\frac{1}{4}$ inch each way, was crushed by 7,318 lbs.

A cube of wrought copper, of the same size, by 6,440 lbs.

Of brass, by 10,304 lbs.

Of cast tin, by 966 lbs.

Of lead, by 483 lbs.

An inch cube of elm is crushed by 1,284 lbs.

Of American pine, by . . 1,606

Of Norway fir, by . . 1,928

Of English oak, by . . 3,860

IV. *Of the Strength of Torsion.*—By the experiments of Coulomb, the resistance of wires of the same material, to a force exerted to twist them, appears to increase with the fourth power of their diameters. A similar result follows nearly, from experiments by Rennie, on square bars of cast iron. It would also appear, from a simple course of reasoning, that the resistance must diminish with the distance of the point in the rod to which the twisting force is applied, from the place where it is fixed; for the rod tends, under the action of the force, to form a screw, the distance between whose threads is the same as the distance between the two points. And in the inclined plane which the screw forms when developed, the twisting force will act as if it tended to raise a weight along the surface of the plane, whose altitude is the constant lineal dimension of the base of the rod.

We have no experiments on the absolute resistance to torsion; the following are the relative resistances of different materials, deduced from the experiments of Rennie.

Lead, ...	1,000
Tin, ...	1,438
Copper, ...	4,312
Brass, ...	4,688
Gun Metal, ...	5,000
Swedish Iron, ...	9,500
English Iron, ...	10,125
Cast Iron, ...	10,600
Blister Steel, ...	16,688
Sheer Steel, ...	17,063
Cast Steel, ...	19,562

We are indebted for the above article to *Dr. Renwick's Elements of Mechanics.*

STREPTANTHERA. A genus of ornamental, bulbous-rooted, exotic plants, of the iris order. It takes its name from the twistedness of its anthers. The elegant species, *S. elegans*, is the oldest known one, and was introduced to Britain about 22 years ago from the Cape of Good Hope. It has a height of about 5 or 6 inches; and carries flowers of white and blue and yellow in May and June; and loves a soil of mixed sand and peat and loam.

STREPTANTHUS. A recently discovered genus of ornamental exotic plants, of the cruciferous order. The blunt-leaved and the hyacinth-flowered species are hardy, late-blooming

annuals, — the former from Arkansa, with a height of 20 inches and rose-coloured flowers, and the latter from Texas, with a height of 3 feet and bluish purple flowers.

STREPTOPUS. A genus of ornamental, exotic, perennial-rooted, herbaceous plants, of the smilax family. Five species, all between 10 and 24 inches high, mostly hardly, and blooming in May or June, have been introduced to Britain from North America, Hungary, and Nepaul; and all love a light soil, and are propagated from suckers.

STRICKLE. The whetstone carried on the extremity of the shaft of a scythe.

STRINGHALT. A sudden or very high lifting of the hind legs of a horse at his starting, as if he were affected with a spasm. The disease, or habit, or whatever it be, is not indicated by swelling, tenderness, or any other unhealthy appearance, and has been variously supposed to have its seat in the fetlock, in the hock, and in the spine; and when it is so great as to amount to lameness, it may sometimes be reduced by means of blistering or the cautery.

STROBILANTHES. A genus of ornamental exotic plants, of the acanthaceous order. The sessile species, *S. sessilis*, was introduced from India to Britain about 10 years ago. Its root is perennial; its stems are herbaceous, numerous, simple, erect, quadrangular, very hairy, and about 18 inches high; its leaves are opposite, subsessile, and ovate-heart-shaped; and its flowers come out in the axils of the bracts, and are sessile and solitary, and expand in succession from below upwards, several at a time, and have a pubescent, lilac-coloured, funnel-shaped corolla.

STROBUS. See Pine.

STRONTIA, or Strontites. The oxide of strontium. It was first obtained from strontianite, or native of carbonate of strontia, a mineral found at Strontian in the west of Scotland; and it may be prepared, in a pure state, from either that mineral or the nitrate of strontia. It is an alkaline earth; and resembles baryta in appearance, infusibility, and other properties. Strontium, the base of it, is a heavy metal similar to barium, and decomposes water, with evolution of hydrogen and fixation of oxygen. Strontia, when mixed with water, slakes, causes intense heat, and forms a white, solid hydrate, consisting of one equivalent of strontia and nine equivalents of water, and possessing the properties of solubility in boiling water, insolubility in alcohol, fusibility with a red heat, infusibility with the strongest heat of a wind furnace, and resolvability from hot saturated solution in water into transparent, thin, quadrangular, tubular crystals. The solution of strontia has a caustic taste and an alkaline reaction; and is a delicate test of the presence of carbonic acid in atmospheric air and other gaseous mixtures. The salts of strontia are most conveniently prepared from the carbonate, and are not poisonous; and the soluble ones are precipitated by alkaline carbonates. Two of the most important compounds of strontium, next to strontia or the oxide, are the chloride and the sulphuret.

STROPHANTHUS. A genus of ornamental, tropical, evergreen shrubs, of the dog's-bane family. Three species have been introduced to Britain from respectively India, China, and Western Africa; and two of these—the forked, with rose-coloured flowers, and the spreading, with yellow flowers—are about 3 feet high, and bloom throughout the greater part of the year, and love a soil of rich mould, and are propagated from cuttings.

STRUMARIA. A genus of ornamental, greenhouse, bulbous-rooted plants, of the amaryllis order. Ten species have been introduced to Britain from the Cape of Good Hope; and all love a soil of sandy loam, and are propagated from offsets,—most have a height of between 3 and 8 inches,—the majority have pink flowers, and the rest have either white or yellow flowers, —and most bloom in April or the early months of summer, and two or three do not bloom till late in autumn. The name strumaria is formed from a word signifying 'tubercle,' and alludes to the conformation of the base of the style.

STRUTHIOLA. A genus of ornamental Cape-of-Good-Hope, evergreen, small shrubs, of the thymelæa family. Nearly twenty species have been introduced to Britain; and all love a light soil of sandy peat, and are propagated from cuttings,—and most have a height of about two feet, and carry either white or yellow flowers from about the end of spring till about the beginning of autumn. Five of the handsomest are the striated, the shining, the side-flowered, the long-flowered, and the smooth,—all with yellow flowers. The name struthiola alludes to the beak-like form of the seeds.

STRYCHNOS. A genus of corolliflorous, tropical, evergreen, small trees, constituting the type of the natural order Strychneæ. This order is nearly allied to the dog's-bane family, and consists principally of tropical, poisonous, ligneous plants. About a dozen species of it, belonging to three genera, have been introduced to British collections; and six of these—all more or less poisonous, and several of them medicinal—belong to the genus strychnos. The best known species, and one which may serve as a good specimen of the whole, is noticed in the article Nux Vomica.

STUARTIA. A small genus of ornamental, hardy, deciduous shrubs, of the ternstrœmia family. The common or Virginian species, *S. Virginica*, called by Linnæus *S. malachodendron*, was introduced to Britain from Virginia in 1742. Its height, as grown in British shrubberies and pleasure-grounds, is commonly about 8 or 10 feet; its branches come out irregularly from the main stem, and are covered with a brown bark; its

leaves are alternate, and of similar size and shape to those of the common cherry-tree, with fine green upper surface and very acutely serrated edges; and its flowers come out from the sides of the branches, and have a white colour and an elegant and delicate appearance, and bloom from May till August. This plant loves a loamy soil, with some little admixture of peat; and is propagated from layers or from seeds.—The five-styled species, *S. pentagynia*, called by some botanists *Malachodendron ovatum*, was introduced from North America in 1785, and has a similar height to the preceding, and blooms in July and August.—The name Stuartia is honorary of an Earl of Bute who was skilled in botany; and the name Malachodendron is appellationally descriptive of the softness of the tree.

STUB. A wound in the foot or leg of a horse with a splinter. It ought to be carefully examined, and made clean of any part of the splinter which may be found in it, and afterwards treated in the same manner as any other punctured wound. See the article Wound.

STUBBLE. The lower part of the culms of the cereal grasses left standing in the field after the operation of reaping. The burning of stubble was a common practice in the ancient agricultural usages of the Eastern world; and was recommended by some Roman writers on husbandry as an excellent means of destroying the seeds of weeds; and is alluded to in such passages of Sacred Scripture as the following:—"Therefore as the fire devoureth the stubble, and the flame consumeth the chaff, so their root shall be as rottenness;"—"And the house of Jacob shall be a fire, and the house of Joseph a flame, and the house of Esau for stubble; and they shall kindle in them and devour them, and there shall not be any of the house of Esau remaining." The burning of stubble, and even of straw, has been tried also in the modern improved agricultural practices of Europe; but though in some instances seemingly beneficial, it really involves in every case a great waste of manurial matter. See the article Ashes. The leaving of long stubble, by cutting the corn high, was likewise a practice of many of the ancients, and is perpetuated by some of the moderns; but whether the portion of available straw left in the form of long stubble be eaten by cattle depastured upon it, or be simply turned into the soil with the plough, it cannot possibly be so productive of ulterior advantages as if it were cut down, and carried to the farmery, and there employed for fodder and litter. See the article Straw. All principles of good reaping require the culms of corn to be cut as low as possible.

STUBWOOD. Young wood rising from the stubs of felled trees, or any growing wood in hedge-rows different from timber, pollard, or quicks.

STUMP. The stool of a felled tree; or the standing part of a fractured or fallen tree; or any clubbish, lumpish, or basal remnant of a fractured, cylindrical, organic body.

STURDY. See Hydatid.

STURK. A young bullock or heifer. The word is provincial.

STY. A piggery or small structure for the housing of hogs.

STYLE. The middle part of the pistil of a phænogamous plant. It is an elongation of the ovary, and is crowned by the stigma. In some cases it is deciduous, and falls when the ovary is ripe; and in others, it is persistent, and adheres to the fruit.

STYLIDIUM. A genus of curious, ornamental, Australian, evergreen, calyciflorous plants, constituting the natural order Stylideæ. This genus or order is characterized by the position and character of the stigma, and has been the subject of much conflict of opinion among botanists. The stigma was supposed by the older botanists to exist at the base of the column; and was identified by later ones with the fifth lobe of the corolla or lip; but is now known to be situated at the top of the column, in a cavity surrounded by the anthers. The column assumes a position outside of the corolla, by bending back between its lobes; and when touched near its base in the slightest manner with a pin, it instantly leaps forward to the other side of the flower,—and after remaining for a short time there, it gradually resumes its former situation. About a dozen species have been introduced to the gardens of Britain; and nearly forty more are known. Most are natives of New Holland and Van Diemen's Land, and occur in wide dispersion and in comparative profusion from within the tropics to the southern shores. All are herbs or semi-herbaceous shrubs; and most have pink or rose-coloured flowers, adorned with glittering glands. The introduced species vary in height from 6 to 25 inches, and love a soil of sandy peat; and most bloom in summer, and require to be propagated from seeds.

STYLOSANTHES. A diversified genus of tropical, yellow-flowered plants, of the hedysarum division of the leguminous order. Six species,—variously annual, evergreen herb, evergreen undershrub, and evergreen creeper, and all requiring to be propagated from seeds,—have been introduced to Britain; and several more are known.

STYPANDRA. A genus of ornamental, Australian plants, of the asphodel family. Five species—all between 10 and 24 inches high—four of them herbaceous and the other shrubby—three of them white-flowered and the others respectively azure-flowered and violet-flowered—have been introduced to Britain; and the three white-flowered herbaceous ones love a soil of rich mould, and are propagated by radical division.

STYPHELIA. A genus of ornamental, Australian, evergreen shrubs, of the epacris family. Eight or nine species, varying in height from 3 to 7 feet, and carrying either green or pink or

crimson flowers for the most part in summer, have been introduced to the greenhouses of Britain; and most love a soil of sandy peat, and are propagated from cuttings. The name styphelia is formed from a word signifying 'rigid;' and alludes to the compact habit of the plants.

STYPTIC. A medicine or medicinal application used for stopping a flow of blood. Veterinarians cannot depend on any styptic; but must either tie the bleeding artery both above and below the wound, or have recourse to pressure or to the hot iron.

STYRAX. See STORAX.

SUBER. See CORK-TREE and OAK.

SUBLIMATE. See CORROSIVE SUBLIMATE.

SUBLIMATION. A chemical or pharmaceutical process similar to distillation, but yielding the product of the volatilization in a solid form.

SUBSOIL. See SOIL.

SUBSOIL DRAINING. See DRAINING.

SUBSOIL PLOUGH. See PLOUGH.

SUBSOIL-PLOUGHING. The stirring of the subsoil of arable land with a specially constructed plough. It differs from both deep-ploughing and trench-ploughing in its only stirring the subsoil and not mixing any of it with the soil, while they bring more or less of it to the surface. It performs similar effects on the subsoil to those which simple tillage produces on the soil,—pulverizing it, increasing its porosity, accelerating its decomposition or disintegration, and enlarging its capacity for the circulation of air and moisture; and when it is done on kinds of land which are improvable by it, and which possess either naturally or artificially a free and ample subterranean outlet for all excess of water, it materially improves the relations of the subsoil to both the soil and the drainage. But in all its offices within the subsoil itself, it acts in exactly the same way as deep-ploughing and trench-ploughing; and in all its relational offices to the soil and the drainage, in the case at least of all sorts of retentive lands, it does positive harm and no good without the preconstruction of a system of deep subsoil drains; so that a question has been extensively raised, and very warmly debated, whether mere subsoil-ploughing be not essentially useless,—or, in other words, whether all the benefits ascribed to it, and some more, may not in every instance be obtainable from deep-ploughing or trench-ploughing and from subsoil draining. It first came before the notice of agriculturists, as a special georgical operation, in connexion with Mr. Smith of Deanston's system of subsoil draining; and it soon became permanently associated with that system, in the notions and phraseology of multitudes of farmers, under the joint name of Deanstonizing; and in almost all the experimental trials of it which were published during several years, it was so invariably combined in practice with the subsoil draining, that no opinion could be formed from them as to the proportion of the results in any case which were due respectively to the draining and to the ploughing. In 1836, it acquired sudden and extensive popularity, both as a separate operation and as a component part of 'Deanstonizing,' in consequence of the official recommendation of it by Mr. Shaw Lefevre, who had sat as Chairman of the Committee of the House of Commons for enquiring into the distressed state of British agriculture; and it afterwards rose so soaringly into fame that a great and steadily increasing number of Smith's subsoil-ploughs were ordered from the principal manufacturers, not only for most of the agricultural districts of Britain, but for Sweden, Prussia, European Turkey, the West Indies, and America; but it was challenged from the first, by some of the most astute agriculturists, and even by Mr. Smith of Deanston himself, as a perfectly worthless or a positively mischievous operation apart from efficient subsoil-draining, and as not at all suitable for every kind of land; and it has eventually come to be regarded by a large body of the ablest georgists either as an operation which can never be preferable to deep-ploughing or trench-ploughing, or as one which can be economically practised only in particular circumstances or within a very limited range of adaptations. Many farmers, however, and even some agricultural writers, confound it with deep-ploughing and trench-ploughing, or regard all the three as simply varieties of one operation; and since the stirring of the subsoil in some way or other is generally allowed to be more or less advantageous on many kinds of lands, and very particularly so on some stiff and cohesive ones, we shall best consult the instruction and convenience of our readers by here discussing the whole subject. See the articles PULVERIZATION, AERATION, PLOUGHING, DRAINING, SOWING, and DRILL-HUSBANDRY.

"The chemical effect of pulverizing and breaking up a subsoil," says Mr. Cuthbert W. Johnson, in the 10th volume of the Quarterly Journal of Agriculture, "is certainly advantageous to the plant in two ways, besides others with which we are very likely at present unacquainted;—first, it renders the soil penetrable to a much greater depth by the roots or minute fibres of the plant, and consequently renders more available any decomposing matters, or earthy ingredients, which that substratum may contain; and secondly, it renders the soil much more freely permeable by the atmosphere, rendering, in consequence, a greatly increased supply not only of oxygen gas to the roots of the plants, but also yielding more moisture, not only from the soil, but from the atmospheric air, which moisture, let it be remembered by the cultivator, is in all weathers as incessantly absorbing by the soil as it is universally contained in the atmosphere, abounding most in the latter, in the very periods when it is most needed by the plants, that is, in the warmest and driest weather. This property possessed by the soil of absorbing moisture from the atmosphere,

and the importance of increasing that power by pulverizing the soil, is not nearly so well understood as is desirable, although the farmer has the means of convincing himself of the fact by the most simple experiments. It is, in truth, an almost unfailing test of the comparative value of soils, as was long since observed by Sir H. Davy,—a conclusion in which I have often had occasion to agree. 'The power of the soil,' says this great chemist, 'to absorb water by cohesive attraction, depends, in a great measure, upon the state of division of its parts; the more divided they are, the greater is their absorbent powers. The power of soils to absorb moisture from air, is much connected with fertility; when this power is great, the plant is supplied with moisture in dry seasons, and the effect of evaporation in the day is counteracted by the absorption of aqueous vapour from the atmosphere by the interior parts of the soil during the day, and by both the exterior and interior during the night. The stiff clays, approaching to pipe-clays in their nature, which take up the greatest quantity of water, when it is poured upon them in a fluid form, are not the soils which absorb most moisture from the atmosphere in dry weather; they cake, and present only a small surface to the air, and the vegetation on them is generally burnt up almost as readily as on sands. The soils that are most efficient in supplying the plant with water by atmospheric absorption, are those in which there is a due mixture of sand finely divided, clay and carbonate of lime, with some animal or vegetable matter, and which are so loose and light as to be freely permeable to the atmosphere. With respect to this quality, carbonate of lime and animal and vegetable matter are of great use in soils,—they give absorbent power to the soil, without giving it likewise tenacity; sand, which also destroys tenacity, on the contrary gives it little absorbent power. I have compared the absorbent powers of many soils with respect to atmospheric moisture, and I have always found it greatest in the most fertile soils, so that it affords one method of judging of the productiveness of land. One thousand parts of a celebrated soil from Ormiston, in East Lothian, which contained more than half its weight of finely divided matter, of which eleven parts were carbonate of lime, and nine parts of vegetable matter, when dried at a temperature of 212°, gained in an hour by exposure to air saturated with moisture at a temperature of 62°, eighteen parts; 1,000 parts of a very fertile soil from the banks of the river Parret, in Somersetshire, under the same circumstances, gained sixteen parts; 1,000 parts of a soil from Mersea, in Essex, worth 45s. per acre, gained thirteen parts; 1,000 parts of a fine sand from Essex, worth 28s. an acre, gained eleven parts; 1,000 of a coarse sand, worth 15s. per acre, gained only eight parts; 1,000 of the soil of Bagshot Heath gained only three parts.' And this absorbent power of atmospheric moisture is not only an inherent property in all fertile soils, and a property which is increased by their pulverization, but it exists in a still more remarkable degree in the commonly employed manures of the cultivator, and that, too, nearly proportionate to their commonly assigned value. The following are the results of my own experiments:—One thousand parts of horse-dung, dried at a temperature of 100°, absorbed, by exposure for three hours to air saturated with moisture at 62°, 145 parts; 1,000 parts of cow-dung, under the same circumstances, absorbed 130 parts; 1,000 parts of pig-dung absorbed 120 parts; 1,000 parts of sheep-dung absorbed 81 parts; 1,000 parts of pigeons' dung absorbed 50 parts; 1,000 parts of a rich soil worth two guineas per acre, absorbed 15 parts. This attractive power of the earths, and of manure, from the moisture of the atmosphere, is one of the most important facts to be kept in mind by the farmer, when he is considering the pulverizing and deepening his soils. It is also a property which all plants possess in a certain measure, but some in such a perfect degree as to depend entirely upon it for all the moisture they need. Thus, the aërial epidendron, *Epidendron flos aeris*, is often employed by the natives of the east, on account of the elegance of its leaves and flowers, and the exquisite odour which it diffuses, as an ornament, suspended by a silken cord from the ceilings of their rooms where, from year to year, it continues to vegetate, putting forth new leaves, new blossoms, a new fragrance, entirely supported by the moisture and gases of the surrounding atmosphere. Many of the native plants of the east nearly support themselves in the same way; some of the mosses of this country almost do the same. The quantity of water consumed by plants when in a state of healthy vegetation, is in fact so great, that, if it was not for the gentle steady supply thus imperceptibly furnished to the soil by the atmosphere, vegetation would speedily cease, or only be supported by incessant rains. Thus, Dr. Hales ascertained that a cabbage transmits into the atmosphere, by insensible vapour, about half its weight of water daily; and that a sunflower three feet in height transpired in the same period nearly two pounds weight. Dr. Woodward found that a sprig of mint, weighing 27 grains, in seventy-seven days emitted 2,543 grains of water; a sprig of spearmint, weighing 27 grains, emitted in the same time 2,558 grains; a sprig of common nightshade, weighing 49 grains, evolved 3,708 grains; and a lathyris of 98 grains emitted 2,501. It has been shown by the experiments of M. Saussure with some sprigs of peppermint, that, when supplied with pure water only, and allowed to vegetate for some time in the light, that they nearly doubled the portion of carbon they originally contained. This they could have procured only from the atmosphere; and under these circumstances, there is now little doubt of the cor-

rectness of the conclusion of M. Berthollet, that plants, by means of their leaves, have the power of decomposing the water as well as the carbonic acid of the atmosphere, and furnishing with these elements new combinations. How essential a free access of the atmosphere is to the roots of plants, was long since shown by M. Saussure, who found that oxygen gas is absorbed by the roots of plants, as well as by their leaves, and that it is at the roots united with carbon, and transmitted to the leaves to be decomposed. Even the branches absorb oxygen: in its absence flowers will not even expand. The advantages of a free access of oxygen to the roots of plants, has been still further shown experimentally: it has been proved that their vegetation is greatly increased by nourishing them with water impregnated with oxygen gas; hence, too, the superiority of rain-water. Some remarkable experiments were made by Mr. Hill, demonstrative of the great benefit plants derive from oxygen gas being applied to their roots. Hyacinths, melons, Indian corn, &c., were the subject of the experiments. The first was greatly improved in beauty, the second in flavour, the last in size, and all in vigour. This is another use of a free access of atmospheric moisture; for M. Humboldt has clearly shown that a dry soil is quite incapable of absorbing oxygen gas. Now, it must be evident, even to the most listless observer, that the more deeply and finely a soil is pulverized, and rendered permeable, the greater will be the absorption of both oxygen and watery vapour from the surrounding atmosphere.

"And by facilitating the admission of air to the soil, another advantage is obtained, that of increasing its temperature. The earths are naturally bad conductors of heat, especially downwards. Thus it is well known, that, at the siege of Gibraltar, the red-hot balls employed by the garrison were readily carried from the furnaces to the batteries in wooden barrows, whose bottoms were merely covered with earth. Davy proved the superior rapidity with which a loose black soil was heated compared with a chalky soil, by placing equal portions of each in the sunshine;—the first was heated in an hour from 65° to 88°, while the chalk was only heated to 69°. This trial, however, must not be regarded as absolutely conclusive, since the surfaces of the black soils naturally increase more rapidly in temperature when exposed to the direct rays of the sun, than those of a lighter colour. A free access of air to all soils also adds to their fertility, by promoting the decomposition of the excretory matters of plants, which otherwise would remain for a longer period, to the annoyance of plants of the same species.

"To the truth of these conclusions and laborious experimental researches of the chemist, does not the practical testimony of the ablest cultivators of all countries and in all ages concur? Thus, in enforcing the advantages of rendering the soil more completely permeable by the atmosphere, nearly two thousand years since M. P. Cato asked the Italian farmers, 'What is good tillage? To plough. What is the second? To plough. The third is to manure.' Cato, however, mistook the cause of the benefit, for he says, 'He who stirs his olive-ground oftenest and deepest, will plough up the very slender roots; if he ploughs ill, the roots will become thicker, and the strength of the olive will go to the root.' Virgil, where giving an erroneous explanation of the advantages of paring and burning, says, 'The heat opens more ways and hidden vents for the air, through which the dews penetrate to the embryo plants.' Do not, at this very period, Lord Leicester and all the best of England's agriculturists, find the greatest advantage from stirring the ground between their rows of drilled turnips, for the sole purpose of promoting the access of the air to their roots; and that, too, on soils where a weed is hardly to be seen? Is not one great object of fallowing to produce, by pulverizing and deepening the soil, the same result? Did not Jethro Tull labour long, and sometimes too sanguinely, in illustrating the same position? And does he not support the subsoilers' conclusions when he says,—'I have had the experience of a multitude of instances, which confirms it so far, that I am in no doubt that any soil (be it rich or poor) can ever be made too fine by tillage. For it is without dispute, that one cubical foot of this minute powder may have more internal superficies than a thousand cubical feet of the same or any other earth tilled in the common manner; and I believe no two arable earths in the world do exceed one another in their natural richness twenty times; that is, one cubical foot of the richest is not able to produce an equal quantity of vegetables, *cæteris paribus*, to twenty cubical feet of the poorest; therefore it is not strange that the poorest, when, by pulverizing, it has obtained one hundred times the internal superficies of the rich untilled land, should exceed it in fertility; or, if a foot of the poorest was made to have twenty times the superficies of a foot of such rich land, the poorest might produce an equal quantity of vegetables with the rich. Besides, there is another extraordinary advantage when a soil has a larger internal superficies in a very little compass; for then the roots of plants in it are better supplied with nourishment, being nearer to them on all sides within reach, than it can be when the soil is less fine, as in common tillage; and the roots in the one must extend much farther than in the other; to reach an equal quantity of nourishment, they must range, and fill, perhaps, above twenty times more space, to collect the same quantity of food. But in this fine soil, the most weak and tender roots have free passage to the utmost of their extent, and have also an easy, due, and equal pressure everywhere, as in water.'

"And it is fortunately in our power to prove

that a thorough subsoil-ploughing or trenching is a *permanent* improvement of the soil,—is productive of continued good results for a series of years after the operation has been performed. I have often had occasion to remark this in my own experience; and that how slowly ground which has been once disturbed acquires its original degree of solidity, every railroad contractor or builder can furnish satisfactory evidence. Neither are the good effects of this deep-soil cultivation merely dependent upon the effects of the manure being more deeply placed, or more widely diffused in the soil; the mere loosening and extended pulverization of any soil, is certain to render that soil more productive. It is seldom that any experiments can be carried on to any extent, which will prove this fact more conclusively than those made some years since by Mr. Withers and other planters in Norfolk, with their timber plantations, of which, nearly in his own words the following is the detail. In the year 1811, five acres of poor black sandy land were planted in the parish of Holt; the land had been recently inclosed from the common, and was covered with heath and whins; Scotch fir, and a proper assortment of deciduous trees, were planted in large holes; the fir succeeded pretty well, but the other trees made no progress; and although, he adds, 'I yearly filled up the vacancies occasioned by death and decay, I found, at the end of four or five years, that all the trees but the Scotch fir, with very few exceptions, were either dead or in a dying state. I then had all the ground trenched, and all the vacancies filled up with oak, ash, chestnut, elm, and other trees; and I have kept it regularly hoed, and free from weeds ever since. The consequence has been, that the last-mentioned trees have made such a rapid growth, that I have been enabled to clear away the greater part of the fir, and the remainder must be taken out in a year or two, to give space for the other trees. One mountain-ash, which had escaped the deadly effect of the heath, whins (and iron-bound soil), gave a decided proof of the advantages of trenching and cleaning the land. This tree had barely kept alive, not making more than two or three inches of wood in a season; but in the year following the trenching, it threw out two leading shoots, the smallest of which, when cut off at Michaelmas, measured six feet two inches.' In the spring of 1819, another piece of ground, containing half an acre, adjoining the five acre field, was planted with the same description of trees. 'This land was trenched two feet deep, and has since been kept perfectly clean; and so great is the advantage of preparing the land properly, in the first instance, that the trees in this piece are now much superior to those planted eight years before, although the latter have had the benefit of hoeing for the last nine or ten years.' With regard to field crops, the testimony in favour of subsoiling the same kind of light sandy soil is equally important and unanswerable. Thus, Sir Edward Stracey, the inventor of the Rackheath subsoil-plough, says, 'I have broken up nearly 500 acres of heath land with the plough. My crops have been nearly doubled. The wheat produced on the land so broken up has been fine plump grain, weighing about 63½ lb. to the imperial bushel, has produced the best price in the market, where, before the deep ploughing, the same land scarcely produced the seed. The wheat was so poor and shrivelled, that nobody would look at it; and, as I had no manure to lay upon the ground, I can ascribe the goodness of the crop to nothing but the deep ploughing.' And for heavier soils, the evidence in favour of subsoil-ploughing is nearly equally valuable. In the year 1838, an experiment was made by Sir James Graham, which is important in several respects. It was on a field of about eight acres, of the poorest and wettest land. 'The surface-soil is about five inches deep of black earth, of a peaty quality; the subsoil is a weeping retentive clay, with sand and rusty gravel intermixed; this clay extends to the bottom of the drains, which are of tile, laid thirty inches deep in every furrow. This field was rented by the out-going tenant at 4s. 6d. per acre. It was in pasture of the coarsest description, overrun with rushes and other aquatic plants. After draining on one-half of this field, I used Mr. Smith's subsoil-plough. On the other half I trench-ploughed to the depth of ten inches, by two ploughs following in succession; in the first part, not mixing with the surface any of the subsoil,—in the last part commingling the surface and the subsoil in nearly equal proportions. The whole field was heavily but equally manured, and planted with potatoes; and though the potato crop, even on good land in this neighbourhood (Cumberland), was below an average, yet the crop in this field exceeded an average, and yielded about twelve tons per acre. The field is equally drained in every part. The crop was so equal throughout the field, that I am unable to pronounce positively which part was the best; but I am inclined to give the preference to that portion where Mr. Smith's subsoil-plough was used.'

"It is always refreshing to find the observations of the farmers confirming the experiments of the chemist, as in those which have been made by the Hampshire farmers, who find, in the retentive soils of their stiff clay formations, such as those in the north of that county, that when they are reduced, by dint of ploughing, to a fine mouldy state, so that the atmosphere can freely penetrate through them, that then the surface of the subsoil speedily becomes very moist, and continues so during the warmest weather. The more finely the soil is divided, the more steadily moist the surface of the substratum becomes. The farmers of the chalk formation in the same county also have remarked, in the wheat crops

growing on the edge of chalk-pits, that as the soil near the edge of the pit becomes thus loosened by the removal of the earth, that then the roots of the wheat-plants growing in the immediate neighbourhood of the pits, elongate themselves in a remarkable manner, some of them reaching to a depth of three or four feet, and this, too, in the same chalk, of which the superstratum is principally composed. In this and similar instances, the extension of the roots of the plant in search of nourishment is well worthy of remark, as proving the efforts which a plant thus situated makes to acquire nourishment, which, in such instances, is most likely either moisture or the gases of the atmosphere, since here we find, that the chemical composition of the substratum is very similar to that of the surface-soil. The required ingredient, therefore, could not be chalk or silica; and it is not likely that alumina was needed, from the small proportion in which it exists in plants. Decomposing organic matters must be nearly absent from the iron-bound substratum, so that atmospheric air and water were the only food of plants likely to be found by the roots of the wheat-plant in diving so deeply into the loosened chalk.—Such, I think, are the reasonable advantages derivable from the subsoiling system,—benefits which, on most soils, must be more or less easily within the reach of the cultivator. It possesses, too, the great advantage of improving the land from its own resources. No other district need be impoverished, no expensive artificial fertilizers procured, to enable the farmer to render that portion of his land productive, which he may have hitherto neglected; he has only to avail himself of the advantages which the improved construction of agricultural machinery now offers for his service."

Three things in this long abstract from Mr. Johnson's paper require to be taken with important modifications,—first, subsoil-ploughing, in any case, can produce the effects he ascribes to it only when superinduced on efficient subsoil draining; second, the permanency of its effects is experienced only on some lands, and either somewhat limitedly or scarcely at all on others; and third, the beneficial effects of it, in most cases, do not result properly from a mere stirring of the subsoil, irrespective of the mixing of some of it with the soil, but may be realized also, and even combined with other advantages, by means of deep-ploughing and of trench-ploughing. These points, though with rather undue tendency to the opposite extreme, are well argued in the following extract of the Quarterly Journal's review of Mr. Shaw Lefevre's manifesto of 1836:—"Mr. Smith is naturally favourable to his own contrivance, of which we think he speaks more favourably than it deserves; and, thinking so, we do not admire his subsoil-plough any more than we would adopt his theory, or follow his objectionable practice of taking two white crops in succession. With all his predilection for the subsoil-plough, had this direct question been put to him, If he thought it impossible to improve land to the highest degree of fertility without subsoil-ploughing? he knows farming better than to have answered it in the affirmative; whereas had the same question been put to him in reference to thorough draining, he would at once have given an affirmative answer. He therefore justly deprecates subsoil-ploughing as a mischievous operation, without the preparation of thorough draining. Thus, to the query, 'Have you used your subsoil-plough without any auxiliary permanent drains?' he answers, 'I have, and it is the worst thing possible to deep-plough land without having it first drained; and it is upon that ground that in England, the shallow-ploughing is so much resorted to. The deeper stiff clay is ploughed the worse it is, because there is thereby a greater reservoir formed to hold water.' 'Supposing the instance of a marsh, where you have no fall of water, and you have about eight or nine inches of soil upon the surface that is marl, and underneath you come to a stiff substratum of clay, and it is almost impossible to get water off, the fields are separated by drains, and scarcely any fall for the water, would you then recommend your subsoil-plough?' 'Certainly not: I think it would just make a reservoir for more water to lodge.' Again, in his pamphlet on thorough draining, he intimates, 'I have been often asked if I would recommend subsoil-ploughing of land which had not been drained? To this I answer, certainly not; for until there is an escape for the water through the subsoil, any opening of it but provides a greater space for holding water, and will rather tend to injure than improve the soil.' . . 'So soon as wet lands are thoroughly drained, deep-ploughing may follow with the greater advantage, but not sooner.' Thus, having good authority for believing that without thorough draining, subsoil-ploughing is a mischievous operation, we may also safely believe that with it subsoil-ploughing is a very innocent operation, so innocuous as to do as little good as harm.

"The theory broached by Mr. Smith, and readily adopted by Mr. Shaw Lefevre, that subsoil ploughed with the subsoil plough remains ever after friable, and is so maintained and accelerated by the action of the water and the action of the atmosphere, which is constantly going like a tide into and out of the soil, admits of doubtful acceptance from its improbability. It is a well ascertained physical fact, that water percolating through any state of soil has a tendency to consolidate it, and especially it will most easily consolidate friable soil. Pour water upon loose sand, and observe how firm the sand immediately becomes. Observe how easily a fine barley-seed furrow is consolidated by a shower of rain. Perceive how firm the soil becomes over a deep drain. These being natural effects

produced by natural causes, what is to prevent the consolidation of subsoil by the percolation of water, although it had been loosened by the subsoil plough, especially when placed under a superincumbent weight of earth? Clay soil having a natural affinity for water, its texture does not 'clap' or consolidate so obviously by the action of water as friable soil, though it poaches on the surface much more readily. Air is found in the earth at the lowest depths; but that its action can be so sensible on loosened subsoil, placed under a thick stratum of earth, as to admit of a comparison with those chemical changes which it effects on the surface of the soil in fallow, 'owing to its exposure to the action of the wind and rain,' especially when the essential ameliorating element of light is necessarily excluded from the subsoil, is a proposition to which few scientific minds would give assent.

"Subsoil-ploughing is surely not 'applicable to all qualities of subsoil.' What could it effect on a subsoil of trap, of which there are numerous instances in this country and Ireland? There are subsoils, both alluvial and diluvial, so occupied with erratic blocks, as to render the admission of any kind of plough impracticable. Those in some parts of Kincardine and Aberdeenshires, and the county of Antrim in Ireland, are so full of primitive and trap blocks as to form a sort of causeway under the arable soil. The subsoil of gravelly deposits is frequently full of large and land-fast blocks of stratified rock. From 14 to 16 inches under the surface is the depth recommended by Mr. Smith for subsoil-ploughing, and 6 inches of earth is thought desirable to be between the sole of the plough and the tiles, the depth to the tiles thus being 22 inches; but there are many persons who make their tile drains only 24 inches in depth, in which cases, were they to practise subsoil-ploughing as here recommended, they would inevitably destroy their drains. It would, of course, be foolish to make the attempt; and yet the probability of such attempts being made by inconsiderate persons, shows the imminent danger of recommending the indiscriminate use of the subsoil-plough. Subsoil-ploughing is like an edged tool, which is only safe in the hands of an experienced operator.

"If depth of soil is all that is desired to be obtained by subsoil-ploughing, that object may be more easily and effectively obtained by ploughing a little deeper than usual with the common or with a four-horse plough. This implement is more easily drawn than a subsoil-plough, inasmuch as it chiefly works in the surface soil; and a deep arable soil is more effectually procured by it, in a shorter period of time, inasmuch as it brings some of the subsoil, of whatever quality it may be, 'as in fallow,' to more thorough 'exposure to the action of the wind and rain' and light, than can be done by the subsoil-plough with its once repeated subterranean operation. Some farmers, it is true, object to bringing to the surface any species of subsoil, as being deleterious to vegetation. This objection has no validity in any case where the soil and subsoil have been thorough drained; and it is less valid in cases where the subsoil is nearly similar to the surface soil, as carse clays, black mould, loams, and such like. But however 'tilly' the subsoil is, when mixed in a small proportion at a time, in comparison with the arable soil, after being exposed to the meliorating influence of the light and air, it can never materially injure vegetation. But for our part, we see no necessity for wishing an inordinate depth of workable soil. Six inches form a fair average furrow depth; and if there is as much below it of well dressed soil, plenty of scope will be afforded for the rumination of the roots of the plants usually cultivated. We consider the quality or heart of the soil beyond the depth of the usual plough furrow, of much more importance than its quantity; and, of course, six inches of subsoil is much more easily put in heart than sixteen. We have ploughed deep black mould, resting upon retentive clay, sixteen and ten inches deep, at different parts of the same field, with a four-horse plough, after it had been drained, and we could perceive no advantage on the crops for years after, on the deeper portion. Most of the plants which are cultivated in the fields, being fibrous rooted, do not require great depth of soil to thrive in. We have, indeed, traced the root of broad red clover, six feet in depth, through a fissure in a bank of clay loam, which had been carried away by the irruption of a rapid stream in time of flood; but the plant which sent forth this long foraging root was no larger than its neighbours. We have followed the tap-root of a wheat plant for a foot through the soil, but its produce was not greater than that of others around it. These facts are not marvellous, because, had the energies of those plants which were exerted in the prolongation of root, been directed to the formation of leaves or seeds, their products would have been more valuable. It was the scantiness of food that impelled them to roam abroad in search of it; had they found abundance of food around their roots, like abundantly fed fowls, they would have had no temptation to wander so far from home.

"Whilst expressing our convictions on the inutility of subsoil-ploughing, we have been frequently interrogated, would you not break the pan that is below? Break it up and bring it to the surface by all means, if it is within reach of common ploughing, whether the land has been thorough-drained or not. But all this apprehension of the moorband pan is founded on an erroneous conception of its origin. How does it originate? It is never found in subsoils of pure clay, of black mould, of hazel loams, of sand or gravel. It is quite impossible it should be found in such situations. The pan or crust is a deposition of iron, and can only be deposited on such subsoils as admit of a certain degree of per-

colation of water, but not faster than the water may have time to deposit the iron. Hence the pan or crust is only found on subsoils of clay having gravel embedded in them. It is quite obvious from the nature of the deposition, that were there quick absorption of the water, or, in other words, were the subsoil thorough drained, there would be no deposition of pan. The iron in the pan is in a state of hydrate, is soluble, and of course injurious to vegetation; but when this hydrate becomes dry, by exposure to the action of the air, it is converted into a pure oxide, which is insoluble, therefore innocuous to vegetation, and which generally mixes with, and forms a component part and colouring matter of, the soil. The most rational method, therefore, of getting quit of pan is to render the soil thoroughly dry; and any other method is only a temporary expedient. But after all, the extent of peculiar subsoil which can generate pan must be comparatively small, and is chiefly to be met with under peaty earth in moorland districts.

"It is desirable that farmers, particularly small farmers, should incur no more expense in the purchase of implements than what is absolutely necessary for the right management of their farms. But, independently of this circumstance, many small farmers have not two pairs of horses of sufficient strength to work a subsoil-plough. We know those who have tried it and could not succeed to work it with fewer than three pairs of horses. It is said that the Muirkirk subsoil-plough is more easily worked than Mr. Smith's; but whether it does its work better or not, which is the chief criterion of excellence, we do not pretend to decide. There is another consideration which is not unworthy of notice, in reference to any extraordinarily heavy work to be performed on a farm. We may propound it as an axiom in horse labour, that every kind of work which requires more than the combined efforts of two horses to execute, is injurious to the horses themselves. When more are yoked together, there is so much counteraction in performing work, that the weak and sanguine tempered horse is always in the end sure to suffer. By using the four-horse plough much in bringing in land, trench-ploughing, splitting down old dykes of turf, and tearing up old decayed tree roots, two very powerful horses of our own, both of sanguine temperament, suffered so severely as to superinduce inflammation in the lungs that terminated in helpless broken wind, and so became unfit for ordinary farm work. We afterwards tried to execute much of the roughest part of that kind of work by trenching with the spade, and found it much more cheaply done, taking into account its at once finished effectiveness. Deep-ploughing cannot, of course, be executed, in present circumstances, otherwise than with horses; but it is the easiest kind of hard labour they undertake; and two strong horses will turn over a deep furrow of thorough drained land, and four horses a furrow of sufficient depth for every purpose of culture."

Subsoil-ploughing, whether judged by theory or by the many appeals to experiment which have been reported in the agricultural periodicals, is least suitable in very light lands, as it tends to make them too loose,—and in very strong plastic clay subsoils, as they immediately or speedily run together again; and most suitable in lands with a strong moorband pan between an open soil and a porous subsoil, as it instantly breaks up the pan, and renders the whole mass of earth permanently absorbent,—and in a subsoil of marly clay or in one of mixed rubble and clay, as it produces a permanent openness and porosity,—and in half open or lazily absorbent lands of all kinds in very rainy districts, as it permanently increases their capacity of letting surface water rapidly down to the drains. But in some cases in which proper subsoil-ploughing is useless, trench-ploughing may be beneficial; while in most cases in which it is eminently useful, trench-ploughing may be equally or superiorly beneficial. Mr. Stephens, in his Book of the Farm, makes this out so well by a combined appeal to principle and report and experiment, that we cannot better state the comparative claims of subsoil-ploughing and trench-ploughing than by making ourselves debtors to him for the passage:—"There is a mode of trenching ground," says he, "which is best done with the plough, its object being to imitate the work of the spade by descending deeper than the ordinary depth of furrow, and of commixing part of the subsoil with the surface soil, which has been probably rendered effete by overcropping. Ground can be trenched with the plough in two ways, either with a large sized common plough drawn by 4 horses, or with one plough going before and turning over an ordinary furrow-slice, and another following in the same furrow drawn by 2 or more, usually with 3 horses, or both ploughs drawn by 3 horses each. It is best performed across the ridges. In either of the above ways the same effect is produced in similar soil, breaking up indurated gravel, deepening thin clays, ameliorating stiff clays by exposure to the air, and mixing old and new soils together, the ultimate effect on all being to deepen that portion of the soil which is used by the cultivated crops. In one respect trenching has the same effect as subsoil ploughing, namely, the stirring of the ground to the same depth, the first plough turning over a furrow of 7 inches in depth, and the second going 8 or 9 inches deeper, making in all a furrow of 15 or 16 inches in depth; but in another respect the two operations leave the soil in very different states—the subsoil plough stirs the soil to the depth named, but brings none of it to the surface, whilst the trench-plough does not altogether bring that which was undermost to the surface, but commixes the under and upper soils together.

It has been made a question, which is the better mode, if both are not alike, of making the soil fertile?—the advocates of subsoil-ploughing alleging that it is better to ameliorate the subsoil while under the soil by the admission to it of air and moisture; while those of the trench-plough answer, that if the object of both operations is to ameliorate the subsoil, it will become sooner so by being brought to the surface, in contact with atmospheric air and moisture. But, say the promoters of subsoil-ploughing, there are subsoils of so pernicious a nature, having the salts of iron and of magnesia in them, that the upper soil would be much injured by its admixture with such substances. No doubt, answer the trench-ploughers, if the subsoil that contained these noxious ingredients in a large proportion were brought up in quantity, when compared with the bulk of the upper soil, injury would be done to it for a time, but they say it is not the abuse but the proper use of trench-ploughing which they advocate; and of such a subsoil, they would use the discretion to bring up only a little at a time, which they have it in their power to do, until they accomplish their end, namely, that of ameliorating the whole depth of subsoil. But they maintain, that by far the greatest proportion of subsoils do not contain those noxious ingredients; and, besides, the very best and quickest way of getting rid of even these is to bring them at once to the surface, for any of the acids, or the salts of iron, are easily neutralised by the action of lime, which is always applied to the surface; and those of magnesia are most easily reduced on free exposure to the air. And, moreover, they ask, If subsoils shall be ameliorated by air and moisture when stirred by a subsoil, why should they not also be ameliorated when stirred by a trench-plough? And they urge further, that trenching may be practised more safely without previous thorough-draining, than subsoil-ploughing. I have no hesitation in expressing my preference of trench to subsoil-ploughing; and I cannot see a single instance, with the sole exception of turning up a very bad subsoil in large quantity, there is any advantage attending subsoil, that cannot be enjoyed by trench-ploughing; and for this single drawback of a very bad subsoil, trenching has the advantage of being performed in perfect safety, where subsoil-ploughing could not be, without previous draining. Mr. Melvin, Ratho Mains, mentions an instance of a field containing both damp and dry ground; the dry was trench-ploughed in the autumn of 1836, an inch or two of the sandy gravel being brought up, and 'was decidedly increased in fertility,' both in the turnip and barley crops which followed. I trench-ploughed a field of 25 acres of deep black mould which had been worn out, with a 4-horse plough, taking and clearing a furrow from 14 to 16 inches deep in the solid land, and bringing up almost in every part a portion of the tilly subsoil, which was only drained to the extent of a few roods put in the face of a slope exhibiting spouts of water. The turnips that followed were excellent; the barley yielded upwards of 50 bushels per acre imperial, and the year after a part was measured off and fenced, containing 6 acres, to stand for hay, which yielded of good hay 1,999 stones of 22 lb. Another field, the year after, that was not drained, suffered injury after trench ploughing; but that was in consequence of having been caught with a premature fall of rain in the autumn before the trenched land could be ridged up, and it lay in the trenched furrow all winter. It is stated that Mr. Scott, Craiglockhart, Mid-Lothian, 'trench-ploughed, in the winter of 1833–4, with one common plough following another, a field of 20 acres, every two alternate ridges, and he has never observed on any of the crops the slightest difference.' This is, as I conceive, an unsatisfactory mode of testing the value of any sort of ploughed land, as it is possible that the untrenched ridges derived a certain, and it might be a sufficient, advantage, in regard to drying, from the adjoining trenched ridges.—But whilst giving a preference to trench-ploughing over subsoil, I am of opinion that it should not be generally attempted under any circumstances, however favourable, without previous thorough-draining, any more than subsoil-ploughing; but when so drained there is no mode of management, in my opinion, that will render land so soon amenable to the means of putting it in a high degree of fertility as trench-ploughing. Mr. Smith himself acknowledges the necessity of trench-ploughing land in a rotation or so after the subsoil has been subsoil-ploughed, in order to insure to it the greatest degree of fertility. The experience in trench-ploughing after thorough-draining of the Marquis of Tweeddale at Yester, East Lothian, may with great confidence be adduced in favour of the system. I have seen a field on Yester farm under the operation of draining which did not carry a single useful pasture plant, but which afterwards admitted of the turnips being drilled across the face of inclining ground, and of presenting to sheep in winter as dry a bed as they could desire; and no farther gone than the spring of 1841, after the Swedish turnip seed had been sown, a field was trench-ploughed with 3 powerful horses in each plough, bringing up white and yellow tilly subsoil, as unpromising in appearance as possible. The weather being very dry, this till became so hard, that part of the field had to be rolled four times, before they were reduced to powder, and after all the operations there was apparently no sap left in the ground. White turnips were sown, came away, one half being eaten off by sheep; and when the land was ploughed up in spring 1842, it turned up to appearance a fine rich dark mould, rising in friable clods, and not a particle of till to be seen. No one need be afraid to bring up subsoil of any

kind on thorough-drained land after the experience of Yester."

SUBTURF PLOUGH. See PLOUGH.

SUBULARIA. See AWLWORT.

SUCCISA. See DEVIL'S-BIT.

SUCCORY, or CHICORY,—botanically *Cichorium*. A genus of blue-flowered, herbaceous plants, constituting the type of a suborder of Compositæ. All its florets, both of the disc and of the ray, are hermaphrodite; its involucre is surrounded with scales or smaller leaflets; its receptacle is almost or altogether naked; and its pappus is sessile, scaly, and shorter than the pericarp or seed-vessel. The suborder called Cichoraceæ comprises seven tribes or groups, represented by the genera hieracium, cichorium, leontodon, scorzonera, lactuca, hypochæris, and catananche. See the article COMPOSITÆ. One species of the succory genus grows wild in Britain, four have been introduced from other countries, and two more are known; but only the indigenous species and one of the introduced species possess any economical interest, — and both of these are slightly noticed in the article ENDIVE.

The common or wild succory, *Cichorium intybus*, is an indigen of poor gravelly lands, particularly about the edges of fields, in both England and Scotland. Its roots are rather thick and fleshy,—and, in some of the cultivated varieties, long and bulky; its stems are branching, and naturally about two feet high,—but, in the cultivated varieties, from four to eight feet high, and even more; its leaves are naturally oblong-lanceolate and runcinate,—but, in the cultivated varieties, though generally more or less hairy and runcinate, with lobes hooked back, are diversified in shape and in shades of colour; and its flowers are numerous and sessile, and grow in pairs, and have a blue colour and a dandelion-like form, and bloom from June till August. The varieties are numerous; but few or none seem to possess much permanency when raised from seed; and one of the most distinct is a large-rooted kind which the French grow as a substitute for coffee, and call *Chiccoree à café*.

Succory has long been cultivated in Belgium, France, Germany, Italy, and other parts of Continental Europe as a substitute for coffee. Its roots are used for this purpose; and, when dug up, are cut in pieces, kiln-dried or roasted in revolving iron cylinders, and then ground into powder in mills. About one-fifth of the whole weight is lost by roasting; and about 3 per cent. of butter is commonly added to improve the consistence and flavour. The powder is very extensively used by grocers for mixing with coffee; and not only is it innoxious, but it is even preferred to genuine coffee by persons who have become accustomed to it; so that the use of it by grocers is scarcely an adulteration, beyond the undue price they charge for it; and even the succory powder itself is frequently adulterated with roasted pease, roasted beans, roasted damaged corn, and other similar substances, aided by a little Armenian bole or Venetian red as a colouring agent. Large quantities of the root began about the year 1835 to be imported into England; and so much as about 5,000 tons a-year was supposed to be brought from Belgium alone. —The leaves of succory, particularly when freed from a portion of their bitterness and harshness by blanching, have been much used in various parts of the Continent, and were formerly used, by the Romans, in a culinary way; and they also possessed at one time some medicinal reputation for their action on the stomach and the bowels. —The whole herbage is highly esteemed throughout large tracts of the Continent and in some parts of England, for the purposes of forage; but though frequently and urgently recommended to the attention of British and Irish farmers and cottiers, particularly for the feeding of cattle and swine, it continues to lie under a degree of general neglect in this country which is grossly inconsistent with its merits and altogether unaccountable. The well known Arthur Young brought seed of it from France in 1788, and grew it extensively on his farm, and declared, in the Annals of Agriculture, that "on various sorts of soil, there is no plant to rival it;" and Mr. Gorrie of Annat says, "I have paid some attention to the culture and comparative merits of various agricultural plants,—prickly comfrey and the yellow day-lily among the rest; yet I have found the culture of chicory easiest and cheapest in the outset, and also very decidedly most profitable as a perennial crop,—it yielding nearly double of nutritive matter as green food in summer, from the same breadth of ground, to any other plant with which I am acquainted. * * On waste corners, near large towns, no plant cultivated in this climate will bring the cow-feeder nearly an equal return with chicory. It should also hold a prominent place in the garden of every cottager in the kingdom, whether to be used as coffee by the family, or as green food by the cow or pig. Were its culture general in Ireland, it would soon prove of more substantial advantage to the labouring classes in the Emerald Isle than many of the political panaceas of the day." In the only known instance of its being tried in mixture with clover and ryegrass for artificial pasture precurrently to the full growth of the natural grasses, in Scotland previous to the publication of the "General Report," it vegetated satisfactorily, and was relished by the live stock, and continued to grow vigorously through the third year of the ley; and since it did well in such a way, so far north, it may right cordially commend itself as a general forage plant, on suitable soils, in all districts of the more southerly parts of the kingdom.

The proper cultivation and management of succory for the purposes of forage in Britain, are described as follows by Mr. Lawson:—"It

thrives best on rich soils, and such as are rather light and well drained. It may be sown alone, either in drills or broadcast, and mixed in small quantities, amongst grass, clover, and other seeds for pasture lands. When the drill system is adopted, which in most cases is to be preferred, the rows may be at from 15 to 20 inches distant, to admit of hand and horse-hoeing, and the plants should stand at least 6 inches distant in the rows; sowing may be deferred till the month of May; as, if this be done at an early period of the season, the plants are apt to commence running to seed in the autumn months, whereby they will be materially weakened, and the first crop of the succeeding season considerably lessened. The operation of thinning should be attended to when the plants are very young, and they should be pulled with the hand, in soft weather, in preference to cutting them with a hoe, as the roots are very tenacious of life, and will push out new buds although cut a good deal below the surface. One considerable crop of root-leaves may be obtained in the end of autumn the first season, and three, four, or even more, may be obtained under very favourable circumstances during each of the four or five seasons following, particularly if the first cutting be completed about the time of the plants first showing their flowers, when the average height will be from 3 to 5 feet, and, in many cases, the cutting should not be deferred until the plants arrive at a more advanced state, as the stalks then become hard and the future vigour of the plants impaired. The broadcast system should only be attempted where the soil is previously in a high state of fertility and completely free from root and annual weeds. The period of duration from the time of sowing will be from four to six years, if cut regularly before arriving at full flower, after which they may be ploughed up and the ground fallowed to get clear of the roots. If, however, the seed be allowed to ripen, the plants will lose much of their vigour even after the first crop. When drilled, 4 lb. or 5 lb. will be a sufficient quantity of seed per acre; but 10 lb. or 12 lb. will be necessary for sowing broad cast." In consequence of the plant standing so long in the ground, it cannot take a place in any regular rotation on arable land, except in a similar way to sainfoin, lucern, and a four or five or six years' duration of grass; but it is peculiarly well suited to very steep ground or an out-of-the-way corner, or any other little tract which cannot conveniently or at all be tilled with the plough. Two serious disadvantages have pretty generally been alleged against it, and are sanctioned by so high an authority as that of Von Thaer,—that it occasions great labour and expense by the difficulty of eradicating it, and that it acts very exhaustingly on the soil; but both are altogether imaginary; for, as we shall see in next paragraph, it is currently lifted by an easy method of harvesting in districts where its roots are the main object of cultivating it,—and it sits so mildly on the soil as to require but a moderate pre-enrichment of manure, and then to be capable of occupying the land in two successive sowings for its roots, and being afterwards profitably followed by wheat.

The proper cultivation and management of succory for the sake of its roots in Britain are described to the following effect, and nearly in the following words, by a gentleman in a part of Yorkshire where it is much attended to:—"The soil best adapted to it is deep, rich, and loamy; but it will grow upon any land favourable for turnips or potatoes, or intermediate between cold stiff clay and a poor thin sandy land. Some favourite fields are close upon gravel; others are more of a black peaty moor land. No fallowing is absolutely required; but it is better that the land should be winter-ploughed, and prepared as for turnips; it must be as clean as possible,—and, if of a friable light character, not overmuch wrought or 'loosened' in spring. The quantity of manure will depend on the condition of the land; say about four loads of good short dung (ashes, night-soil, &c.), laid on broadcast, as an average to the acre, when ready for rowing up, which will prevent the ridges being twice turned, as in turnip sowing. The period of sowing will depend upon the season, and the condition of the land; the latter end of April or beginning of May is preferable. The double-drill is in use in this district, and the rows should be from 16 to 18 inches in width,—the drills $3\frac{1}{2}$ inches apart. Very great care must be taken that the drills are kept clean, and not suffered to choke, or much ground may be lost, as it is difficult to tell how far they may have 'missed delivery.' They, and the roller attached to follow, may be worked by a quiet old pony. About three weeks or a month after sowing, it will be requisite to hand-pull and weed. No hoe is ever permitted. If necessary, you may employ the pony and a light scuffler between the rows. Particular care must be paid to the cleaning and weeding; and the frequency of the operation will depend upon circumstances. If the land is clean, 16 or 18 women and children may go over it twice in a season; and an acre may occupy them probably about two days. The plants in the drills should be singled two or three inches apart from each other. Dibbling where seed has failed does not appear to answer. Those plants which 'run to head,' must be watched, and carefully drawn when they show flower; or at the final taking up they will prove woody and worthless, like a radish run to seed. They can be carried home and prepared for sale in the same manner as if drawn at maturity. The proper time for taking up the crop depends on the season;—in November, if considered ripe; but experience alone can enable you to fix the precise time. Those who have much will commence sooner than those who have less to take up. The mode of harvesting

in this district is to let the taking up to a man and his family, or a gang of men, at about £2 per acre (which is considered very 'bad pay,' or 'minimum' allowance). The spades are like dock-drawers, 18 inches long, by 2½ or 3 broad; each plant must be 'lifted' with the spade, and drawn by the hand. The followers pick up the plants, and carefully twist off the tops, or leaves, throwing the roots on heaps; and cattle of all sorts being exceedingly fond of the leaves, it is the practice, after getting the roots away as quickly as possible, to turn a large quantity of sheep into the field to devour the relics, or to cart them away to the pastures whilst they are still pretty fresh. From the field the roots are taken to the most convenient washing-place; a running stream, easy of access, with a good gravelly bottom, is invaluable for this purpose. When washed, they are conveyed to the manufactory and there cut by a machine into pieces or lengths of a ¼ or ½ an inch; these again are riddled to separate the smaller from the larger, the thin from the thick ends, which take more drying. They are then placed on a kiln, in bags, about 16 at a time, until ready for roasting—managed in a similar way to coffee; then ground or crushed with shelling stones, and made up for sale. When cut it must not be allowed to remain in heaps for more than a day. Two cutters are worked by one horse; each has one knife only, and two women to feed it."—The Belgian cultivators sometimes use poppy oil-cakes as manure for it, and always apply the manure in the autumn before sowing; and they sow broadcast, and thin out to final distances of 6 inches, and keep the crop clean by hoeing and hand-weeding. The average crop of roots per acre in Yorkshire is from 3 to 5 tons; but some of the cultivators there who have skill enough to grow the crop, cannot succeed in preparing it for the market.

The endive succory, or simply endive, *Cichorium endivia*, was introduced to Britain from India about the middle of the 16th century. It is a highly esteemed salad plant; and is particularly in request at the seasons when lettuce is scarce; but it requires somewhat nice and careful blanching to make it crisp and completely palatable. Three varieties of it are in cultivation,—the green curled-leaved, the Batavian broad-leaved, and the white curled-leaved. The first is preferable for main crops,—and the second for use in autumn and the early part of winter, but does not well withstand frost; and all may be sown in successions from May till the beginning of August, and afterwards transplanted to distances of 12 or 15 inches. Any which are sown earlier than May run to seed in the course of the summer, without becoming duly available for culinary purposes; yet if a few be wanted for the earliest possible use, a small sowing of the white curled-leaved may be made in March or April. The blanching may be done by tying-up after the manner of lettuce, or by earthing-up after the manner of celery, or by heaping around the plants cones of coal ashes or of dry sand, or by covering them, for protection at the same time from frost, with dry leaves of trees or fronds of ferns, or by covering them with garden pots, or with tiles or pieces of wood. The method of embathing in cones of dry sand is the most generally efficient; but requires to be preceded by a careful and close tying-up of the plants at a time when they are perfectly free from moisture.

SUCCOWIA. A handsome, yellow-flowered, hardy, annual plant, of the cruciferous order. It was introduced to Britain from Minorca about 70 years ago; and it constitutes a genus of itself, and is specifically called the Balearic. It has a height of about 10 inches, and naturally blooms in June and July.

SUCCULENCY. A fleshy juiciness in the root, stem, leaves, or other parts of a plant.

SUCKER. A shoot or young twig from the root-crown or root-side of a plant.

SUDORIFIC. A medicine which excites sweating. It enters the circulation, acts on the subcutaneous vessels, and augments the energy of the cuticular glands which secrete the sweat. No known substance acts safely as a sudorific in the horse; but either a mixture of ipecacuanha and opium, or a mixture of emetic tartar, opium, and ginger, beneficially increases his insensible perspiration. See the article PERSPIRATION.

SUET. The fat situated about the loins and kidneys of sheep, oxen, and some other animals. It is harder and less fusible than the fat of other parts of the same animals, or than that of the same parts of other animals; but it differs from these fats, and even from the softest hog's lard, chiefly in consistency,—and, like them, is composed almost entirely of stearine and elaine, or ultimately of carbon, hydrogen, and oxygen. See the articles OIL and FAT. The suet of sheep and oxen, when melted out of the membranes which envelop it, forms tallow, and is largely used in the manufacture of soap and candles; and when fused, it concretes at a temperature of about 100°. See the articles CANDLE, SOAP, and TALLOW.

SUFFOLK GRASS. See POA.

SUFFRUTICOSE PLANT. A plant of intermediate character between an herb and a shrub. It has not perishable, succulent shoots and herbage like the one, nor hard woody twigs and complete buds like the other; yet it is more shrubby in habit and in general appearance than herbaceous. Common lavender is an example.

SUGAR. The principle in vegetable and animal products which is resolvable by fermentation into alcohol and carbonic acid. It is popularly regarded as the principle of sweetness in all sorts of substances; and has often been scientifically defined as the sweet constituent in organic structures and secretions; but it is totally absent in some very sweet substances, both mineral and organic, such as sugar of lead and manna,—and

it is always the immediate principle whence alcohol is evolved, and is in every case resolvable into alcohol with loss of carbon and oxygen; so that it is far more correctly designated the alcoholizable principle than the principle of sweetness. The elementary transpositions by which it passes into alcohol and carbonic acid are noticed in the article ALCOHOL; the process in which these transpositions take place is described in the article FERMENTATION; the forced or artificial evolution of it from the starch of grain preparatorily to its conversion into alcohol is described in the article MALT; the process of converting it into the alcoholic constituent of malt liquors is noticed in the article BREWING; the natural evolution of it from the starch of seeds as food for nascent plantlets is explained in the article GERMINATION; the part which it plays in the progress of the growth and the maturation of plants is noticed in the article NUTRITION; the purposes which it serves as an ingredient in the food of man and of some of the lower animals are glanced at in the article ALIMENTARY PRINCIPLES; the uses of a coarse and impure form of it in the feeding of cattle are adverted to in the article MOLASSES; the plant from which the chief bulk of the sugar of commerce is manufactured is described in the article SACCHARUM; the making of sugar from beet-root and the sugar-maple is noticed in respectively the articles BEET-SUGAR and MAPLE; and a wide variety of other topics connected with the nature, powers, transmutations, preparation, or uses of sugar, are noticed in the articles BIRCH, CARROT, FRUIT, LIQUORICE, BORASSUS, PALM, MILK, SYRUP, HONEY, and many others.

Sugar, we have said, on being excited by a ferment, becomes alcohol or spirit; and this, by a continued natural operation, and by the aid of another ferment, is convertible into acetic acid or vinegar. But two conditions are essential to these changes,—dilution with water and a certain amount of temperature. Sugar, as it exists naturally in vegetable matter, forms an extremely diluted solution, which, combined with other matters, constitutes the juices of vegetables. In this state, if in contact with its natural ferment, one of the principles of gluten which exists in all fruits and other vegetable products, it will commence the process of alcoholization, which being effected under great agitation and ebullition in the liquid, is termed fermentation. Alcohol itself under this fermentation is formed only in a diluted state, in which, being combined with the other principles also of the fruit, it is termed wine. When the whole of the sugar is converted into alcohol, and the temperature is at the proper point, acetification begins, and the alcohol, by a new kind of fermentation, becomes acetic acid; in a word, the wine is converted into vinegar. Pure dry sugar, separated from every other substance, will not ferment at all, and therefore will not become alcohol; neither will a thick syrup of pure sugar. In its dry and crystallized state, therefore, or in that of syrup, sugar remains unchanged; only in the latter form, as the water evaporates by the operation of heat, time, or any other cause, crystals of sugar will form on the sides of the vessel above the surface of the liquid. And as pure undiluted sugar is not convertible into alcohol, so the pure spirit obtained from the vinous liquid by distillation is not convertible into acetic acid, because, in its concentrated form, alcohol, like sugar, is unchangeable.

There are three distinct kinds of sugar to be found in the products of organized matter. The first contains the greatest quantity of fermentable matter, and therefore yields the most spirit. It is found in the sugar-cane, in beet-root, in the maple, in the carrot, the turnip, the parsnip, in cabbage-stalks, in the stalks of all the gramineous tribes of vegetables, and in the leaves, blossoms, and green stalks of most other plants. It is likewise one of the constituents of honey. This sugar, when purified, and freed from foreign matter, is extremely white and hard, crystallizing into oblique four-sided prisms, that have summits with two sides. It is obtained from the vegetables that possess it, by pressing out and evaporating their juice, which holds it, with other matters, in such a state of diluted solution, that it is ever ready, the moment it is separated from its natural vehicle, to enter into spontaneous vinous fermentation. All the sugars obtained from the sources just mentioned are identical in their properties; but that yielded by the white beet-root has a greater power of cohesive attraction than the produce of any other sugar-bearing plant, not even excepting the sugar-cane; and its crystals, in its purest form, are therefore larger and much harder.—The second kind of sugar does not form regular crystals, but, in its purified state, exhibits a white, hard, concrete body, having the shape of a cauliflower. It is inferior to the former in saccharine or alcoholic principle, because it contains less fermentable matter, the ratio of this inferiority being as six to ten. This description of sugar exists ready formed in all kinds of sub-acid fruits, when ripe, such as grapes, apples, pears, cherries, strawberries, raspberries, oranges, and many other varieties, its vehicle being the juice of the fruit, which holds it in solution,—ready, as stated with reference to the first kind, spontaneously to form wine. Starch is chemically converted into this kind of sugar by being treated with sulphuric acid; and when the saccharification is complete, the acid is separated from the sugar by means of lime, with which it unites. Diastase, a principle extracted from crushed malt by maceration in water, also converts starch into sugar. Gum may likewise be changed into sugar by sulphuric acid,—which will likewise saccharify glue. But the same description of sugar may be derived from still more singular sources, one of which is sawdust. This substance is composed, as every one knows, of

lignin, which is the principle of wood. If, then, sawdust be treated with sulphuric acid, it will be converted into gum, which by further treatment with the same acid, becomes sugar. The sawdust that under this process is perhaps the most speedily convertible into sugar, is that produced from the very hard wood of hornbeam. Hemp and flax, the principal constituent of which is lignin, will both produce the same result as sawdust, under the same chemical agency of sulphuric acid; and this power is so strongly preserved through all the various changes they undergo, that sugar may be obtained from old hempen cloth or from linen rags—or more correctly speaking, the lignin of these substances may be converted into sugar by the agency of sulphuric acid. The sugar of milk is of the kind we are now describing, but is less powerful than that from vegetable sources; and though it exists in smaller proportion in the milk of the cow than in that of many other animals, yet the sugar of cow's milk is separated and granulated upon a large scale, in Switzerland, for pharmaceutical purposes. There is a further peculiarity in this sugar, which is, that its best ferment for the production of alcohol is the union of the other ingredients composing the milk, that is to say, the milk in its unseparated condition, acted upon by a small portion of other milk already under vinous fermentation.—The third kind of sugar is uncrystallizable, but remains in the form of a thick dark syrup. It is still lower in saccharine qualities than the last, its ratio, as compared with the first kind, being no higher than four to ten. This is the kind of sugar formed by germination of grain both natural and artificial. It is likewise found in the sugar-cane, in the beet-root, and in the maple, united with the crystallizable sugar, from which it separates under the form of a black thick syrup, known by the name of molasses and treacle. The sugar obtained from the various palm-trees, especially from the palmyra-tree, or borassus flabelliformis, and known in India by the name of jaggery, is likewise of this description. To this we may add the sugars yielded by many of the boletus or mushroom tribes, and that also found in the liquorice-root.

Sweetness to the taste is certainly one of the attributes of sugar; but, as we have already observed, it is an error to call it the sweet constituent of organic matter, because there are other constituents more lusciously sweet. Pure sugar, obtained for common use through the labours of the refiner, carries with it assuredly, in a given weight, the greatest possible quantity of fermentable matter or alcoholic base; but it has not that intensely sweet and cloying flavour peculiar to brown sugar, to treacle and molasses, and to Spanish juice, neither of which affords anything like the same quantity of alcohol. The Spanish juice yields scarcely any; the molasses and treacle, when wholly free from crystallizable sugar, very little. The sweet, cloying, sickly flavour of manna is universally known; it is sweeter than pure sugar, and yet contains no sugar, and therefore produces no alcohol. The peculiar action upon the palate that produces what is termed a sweet taste, is yet unknown; though the sweetness of pure sugar is always distinguishable from every other kind of sweetness.

To make pure syrup requires twenty-nine ounces of the best refined sugar to a pint of water. If such syrup be diluted with water, a little gluten added, and the whole kept at the temperature of 60 degrees Fahrenheit, it will speedily be converted into wine, the alcohol of which may be extracted by distillation. Thus, when sugar is cheap, moist or unrefined sugar, and even treacle, or sugar and treacle mixed, may be substituted for malt; and by the addition of hops and other flavouring substances to a vinous fermented solution of sugar, a much better liquor may be obtained than that brewed from malt, the sugar from which, being produced partly by germination and partly by chemical conversion in the mash-tub, under the influence of the diastase of the malt, is inferior to and much less rich in alcoholic principle, than that used for ordinary domestic purposes.

If sugar be subjected, in its dry state, or nearly so, to the action of heat, it fuses and assumes the appearance of a dark-coloured syrup, which will harden on cooling. This readily dissolves in water, and also in alcohol, which makes it of use for colouring liquors, and many luxuries of the table. If allowed to burn, it acquires a bitter empyreumatic flavour. Sugar thus fused will not again crystallize. It is termed, in this state, caramel by pastry-cooks, and essentia binia by porter-brewers. Though a very wholesome colouring matter for malt liquor, its use is prohibited by law, in favour of a substance much less innocuous.

Sugar will dissolve in water, in all proportions, but not in alcohol unless heated, and then only in very sparing quantities. It has likewise some chemical properties, which ought to be known to housekeepers. It has a very strong affinity for water, of which, in its pure form, it contains 5·3 parts in every 100 of sugar. This cannot be termed its water of crystallization, because it exists in uncrystallizable sugar, and in the mushroom-shaped concretions already mentioned. This constituent water cannot be separated, except by converting the sugar into a saccharate, the nature of which we will explain. Sugar, though not an acid, has the property of combining with certain metallic oxides, and of producing a specific action upon other metallic oxides, and upon some metallic chlorides. In the first case, it forms saccharates; in the last, it liberates the oxygen or the chlorine from the base. With oxide of lead, sugar has two combinations, forming a saccharate and a bisaccharate, the one insoluble, the other the reverse. The first, produced by digesting oxide of lead in syrup, is a

yellow deliquescent mass, wholly uncrystallizable; the last, obtained by boiling oxide of lead in syrup, is ultimately obtained in the form of thick white flocks, very light, quite tasteless, and insoluble. These flocks will ignite and burn like German tinder. A subsaccharate of lead may be obtained, wholly free from water, by mixing pounded litharge with syrup, and evaporating the mass to dryness by means of the sand-bath.

One of the most useful properties of sugar, in household economy, is its action upon the salts of copper, among which the most common are the oxide of copper, and verdigris or acetate of copper. It completely dissolves and neutralizes these salts, totally destroying their poisonous action upon the animal economy. Orfila states that a quantity of verdigris which in an hour would destroy the life of an adult human being, may be swallowed without danger when mixed with a large quantity of sugar or syrup. When copper vessels are used for making jellies from acid fruits, or for preserving fruits in sugar, the quantity of this latter substance necessarily used counteracts the dangerous properties of the copper. From this it is evident that in all cases of accidental poisoning from the use of copper vessels, or from having taken verdigris into the stomach, the antidote is dissolved sugar or syrup, in as large quantities as the stomach will bear. To this may be added water containing sulphuretted hydrogen, which is always to be obtained at any respectable druggist's. The sugar, however, is effective by itself, and will counteract the poisonous qualities of any of the salts of copper. As capers, from the mode of their preparation, always contain a small portion of verdigris, a little sugar should be added to them when employed to make caper-sauce. In stewpan cookery, likewise, if the stewpan be of copper, even though well tinned, a lump or two of sugar, which always improves the flavour of the savoury preparation, also secures the eater of it against any accidental intrusion of the poisonous salts of copper, which, where proper cleanliness is observed, must, if they exist at all, be very minute. But even should they not exist, it is much better to be secured against them, because the apprehension is often more injurious than the reality of danger.

When sugar in solution is boiled with verdigris, a considerable quantity of the cupreous oxide or protoxide of copper is precipitated. Boiled with nitrate of silver or nitrate of mercury, it precipitates the metal uncombined, as it does also when boiled with the chlorides of gold, silver, and platinum. Sugar, with water, in the form of syrup, has the property of dissolving the alkaline earths, lime, magnesia, baryta, and strontia, which are otherwise insoluble in water. All acids have a remarkable action upon sugar, which, if in contact with it for some time, though the acids be afterwards neutralized and separated from it, they render uncrystallizable. This is the case with citric, tartaric, and oxalic acids, which completely and for ever destroy in sugar its property of crystallization. Nitric acid converts sugar into oxalic acid, or into malic acid, according to the mode of its application. Sulphuric, phosphoric, and the hydro-acids, have all a strong action upon sugar, injurious to its due granulation. Alkaline substances also will prevent the crystallization of sugar, and, when mixed in excess, will reduce the first to the third kind. In the manufacture of sugar, therefore, from the expressed juice of the cane, the beet, or any other sacchariferous plant, the quantity of sugar will be less, and that of molasses greater, whenever too much lime is used in the first purification of the juice. There is a strong electrical action in sugar, by which light is produced when two lumps of pure crystallized sugar are rubbed together in the dark, heat being given out at the same time, but in so small a quantity as to be scarcely sensible.

The sugar of commerce, in Great Britain, the produce of our colonies, is derived from the sugar-cane, or *Saccharum officinarum*, one of the gramineous family. Viewed from a distance, a plantation of sugar-canes has much the appearance of a field of wheat before the ears begin to make their appearance. When ripe, the smooth surface of the cane resembles in colour the skin of a ripe apple, varying in tint from the florid to the pale, according to the variety of the plant. Within the thin, crisp rind of the cane is a whitish porous pith, saturated with saccharine juice. This is expressed by passing the canes through three revolving cylinders, each cane entering first between the bottom and the middle cylinders, and being repassed between the top and the middle cylinders. The mill is turned either by cattle, by a water-wheel, or by steam power. The juice is used immediately, or it would ferment. From the mill it runs into a large boiler, in which, for purification, it is heated, but not boiled, with lime. The use of this alkaline earth has a twofold object,—to neutralize the acetic acid which exists ready formed in the woody part of the cane, and is pressed out by the mill, together with the saccharine juice, and to clear this juice from various foreign matters mingled with it. By the application of gradual heat, these impurities form a cake, with the lime, at the surface of the resinous liquid, which is drawn off clear and conveyed to the first boiler. After going through several successive boilers, in each of which it is boiled to a thicker consistence, it at length becomes a thick dark syrup, when it is put into shallow, flat coolers. In the West Indies, before all the molasses has had time to separate from it, the coarse sugar, containing much dirt and impurity, is pressed into hogsheads by the naked feet of the negroes; in which condition it reaches us in the shape of moist, brown, raw, or muscovado sugar. At the Mauritius, the drier estates of which island produce

the best sugar in the world for the refiner, the muscovado is purified in conical moulds, from the inverted apex of which, the molasses drips out, leaving the sugar crystallized and dry, the upper or broader part of the mould containing the best sugar, the quality decreasing towards the apex. The whole contents of the mould, weighing two or three hundred-weight, are, however, mixed to equalize the quality, and the whole is sent home in bags made of the palm leaf. The molasses, mixed with water and fermented, is employed to manufacture rum. A spirit is likewise drawn from the fermented juice of the cane; those plants attacked by the rats in the field, and already in a state of incipient fermentation, being devoted to this purpose. In very damp districts, the cane yields no crystallizable sugar; the whole of the juice is therefore employed in the production of spirit, termed in the Mauritius arrack, in the West Indies taffia. Both this and rum are exceedingly injurious to the human frame, until they have acquired considerable age; and the cause of the unwholesomeness is this:—The acetic acid in the cane juice is not wholly neutralized by the lime first used to temper this juice, because a portion remains in combination with that part of the saccharine liquid that afterwards forms molasses, in which substance acetic acid may always be detected. Added to this, the attenuation of the wash proceeds so rapidly in tropical climates, that acetification has commenced ere distillation begins. The consequence is that acetic acid rises with the spirit, which therefore comes over, attended with acetic ether and a quantity of free acetic acid, both mixed with the spirit and rendering it exceedingly unwholesome. Time will make the ether evaporate, or nearly so; but the acetic acid will remain. This might be obviated, and these two spirituous preparations rendered less deleterious, by treating the wash with lime, by which the acetic acid might be wholly neutralized in the still. In India there exists a much more primitive mode of making sugar from the cane than the one we have described; but the canes of that generally light and sandy soil yield a sugar very deficient in fermentable qualities, and of little value to the refiner.

Raw sugar brought to England is converted into loaf or white sugar by being deprived of its impurities, which consist of mucilage, gluten, molasses, caramel, and some other matters, to say nothing of absolute filth. The sugar is first made into a pap with hot water, as a diluted solution in water would deteriorate it. This pap is next put into conical forms or moulds, and allowed to drain, which clears it from much of its coarse treacle and other substances. It is then mixed with a small portion of lime-water, some bullock's blood, and a quantity of animal charcoal, and injected with steam admitted through various orifices, by which it is dissolved and incorporated with the albumen of the blood and with the bone charcoal, and these with each other and the blood, into a homogeneous mass. This now undergoes various operations of filtering and separation from the refining ingredients, until the pure sugar remains in the form of a limpid and highly clarified syrup, which is then evaporated to the crystallizing point under great pressure, in what are termed vacuum-pans, and then poured into conical moulds. These, after a few days, are placed in a stove heated to 130 or 140 degrees, where they remain until they are baked hard. The loaves are now taken out of the moulds and covered with blue paper, in which condition they are ready for sale.

SUGAR-CANE. See Saccharum and Sugar.

SUGAR OF LEAD, — chemically, *Acetate of Lead.* A salt composed of lead and acetic acid, and much used in medicine, in surgery, in chemical reagency, and in several of the arts, particularly that of calico-printing. It is made, on a small scale, by dissolving either litharge or carbonate of lead or white oxide of lead in distilled vinegar,—and, on a large scale, by a coarse and operose process with sheet-lead and distilled vinegar. In its pure state, it is inodorous, and has a sweet astringent taste, and forms in irregular masses which look like lumps of sugar, but are aggregations of white, glossy, right oblique-angled prisms terminated by dihedral summits. It has a specific gravity of 2·35, and slowly effloresces by exposure to the air, and dissolves in about four times its weight of water at 60° Fahrenheit. It is a powerful poison in even small quantity; yet, when administered in minute doses. with corrective accompaniments, and under circumstances of due caution, it is employed by the human physician as a mighty astringent and sedative, and as a valuable remedy in various kinds of internal hæmorrhages; and as the principal medicinal ingredient in a lotion, it serves well, in both human and veterinary practice, as a remedy for inflammation of the eyes.

SUGAR PEA. See Pea.

SULPHATES. Salts consisting of sulphuric acid in combination with alkaline and metallic bases. Several exist in a natural state; those of lime and baryta are particularly abundant; and all may be artificially formed by the action of sulphuric acid either on the metals and alkalies themselves, or on the metallic oxides or their carbonates. Six—those of baryta, tin, lead, mercury, antimony, and bismuth—are utterly insoluble; six—those of lime, strontia, silver, cerium, zirconia, and yttria—are sparingly soluble; and all the rest are soluble in water. When any sulphates, except those of soda, potash, lime, lithia, strontia, and baryta, are subjected to a white heat, they suffer decomposition, one portion of their sulphuric acid escaping unchanged, and another portion passing into sulphurous acid and oxygen; and when any sulphates whatever are mixed with carbonaceous matter and ignited, the oxygen both of the acid and of the oxide

combines with carbon, to form carbonic acid, and a metallic sulphuret remains. Five important sulphates are noticed in the articles Gypsum, Epsom Salt, Glauber's Salt, Alum, and Copperas; and both these and some others—particularly those of ammonia, potash, and baryta—perform important offices in animal and vegetable nutrition, in the fertilization of soils, in special manuring, and in medicine and the arts. See the articles Ammonia, Protein, Nutrition, Food of Plants, Manure, and Agricultural Chemistry.

Liebig—after showing that sulphur is a constituent of the protein compounds, and is as truly concerned as nitrogen in building up and maintaining the animal organisms, and becomes available to animals through the medium of the plants or parts of plants which they consume as food—says, "Compounds containing sulphur are present in the seeds of all plants, as well as in the plants themselves; and as they are particularly abundant in cultivated plants employed for animal nutrition, it is quite obvious that a substance containing sulphur is absolutely essential to the development of such compounds, in order to supply to them their proper proportion of this element. It is also obvious, that although all other conditions for the nourishment of plants be present, if the compound containing sulphur be either wholly absent or deficient in quantity, the vegetable constituents containing sulphur will either be not at all formed, or they will be generated only in proportion to the quantity of the above compound. The air cannot contain any substances in which sulphur is present, unless indeed we except minute and scarcely appreciable traces of sulphuretted hydrogen. The soil, therefore, must be the only means of furnishing the sulphur so necessary to the growth of plants; and we are ignorant of any form by which it can be assimilated except that in which it enters the roots. The numerous analyses made of the water of mineral springs, furnish us with a satisfactory explanation of the form in which sulphur occurs in soils. The water of such springs is entirely derived from the rain which falls upon the surface of the earth; the water percolating through the earth, dissolves all soluble materials which it may meet in its course. The substances thus dissolved communicate to the water properties which are not possessed by pure water. Water procured from springs or wells is found to be very rarely deficient in soluble salts of sulphuric acid. The liquid obtained by lixiviating good soil from garden or arable land also contains very appreciable quantities of these salts. These facts leave little doubt as to the source whence plants obtain their sulphur; as far as our knowledge extends, they receive it from the sulphates dissolved in the water absorbed by their roots from the soil. Ammoniacal salts, particularly sulphate of ammonia, are rarely detected in spring water; but this is owing to the constant presence of supercarbonate of lime, which effects their decomposition, and allows the escape of ammonia during the evaporation of the liquid for the purposes of analysis. According to our view, sulphate of ammonia is of all compounds containing sulphur the one most fitted for the assimilation of that element. Sulphate of ammonia contains two elements, both of which are equally necessary for the support of vegetable life; these are sulphur and nitrogen, and they form constituents also of vegetable albumen, fibrin, and casein. But what is still more worthy of observation, sulphate of ammonia, viewing it according to the proportion of its elements, or what is termed its empirical formula (O^3, H^3, S, N,), may be considered as a compound of water with equal equivalents of sulphur and nitrogen. Thus, by the simple removal of the elements of water from this compound, its sulphur and nitrogen might be enabled to pass over into the composition of the plants. The ingredients of plants containing sulphur are so composed that one equivalent of sulphur exists for every 25 equivalents of nitrogen. Hence it is obvious that much more ammonia must be offered to plants than that contained in the form of sulphate of ammonia, if all the sulphur of the latter is to become a constituent of the organic ingredients alluded to. This bears a complete analogy to the assimilation of the carbon and nitrogen furnished to plants in the form of carbonate of ammonia. This salt may contain two equivalents of carbon to one equivalent of nitrogen. Hence it is necessary that the carbon of six equivalents of carbonic acid must at the same time be taken up, and enter into combination with the nitrogen, in order to produce the principal nitrogenous constituents which contain one equivalent of nitrogen to eight equivalents of carbon.

"The passage of sulphur derived from a sulphate into the composition of vegetable matter, necessarily indicates that the sulphate has been exposed to the action of the same causes as those by which the decomposition of carbonic acid was effected in the plant; and, therefore, that the sulphuric acid has been decomposed into sulphur and oxygen, the former of which is assimilated, whilst the latter is separated. If we suppose the sulphuric acid to be presented in the form of sulphate of potash or soda, the basis of these salts must be set at liberty after the decomposition of their acid. Now we actually find these bases in all cultivated and even in most wild plants. They are found either united to organic acids, or, what is still more remarkable, they are found in union with the vegetable compounds containing sulphur. The vegetable casein of pease, beans, and other leguminous plants, is itself insoluble in water; but it is very soluble in the form in which it occurs in the plant. This solubility is due to the soda and potash with which it is united. In like manner, the albumen

contained in the juices of plants is combined with an alkali; and we must even suppose that vegetable fibrin, the insoluble ingredient of cereal plants, must have originally been soluble, and have attained its position in the seeds by the agency of alkalies. The potash and soda of the alkaline sulphates which furnish to plants their sulphur, remain, therefore, either in combination with the ingredients containing that element, or they enter into some new state of combination, or, finally, they are returned to the soil. Gypsum (sulphate of lime) is the most generally diffused sulphate; and, being soluble, it may either pass directly into the plant, or it may be decomposed by the carbonate of ammonia existing in rain water, and pass into the plant in the form of sulphate of ammonia. A solution of gypsum containing common salt or chloride of potassium, such as sea water, and the water of most springs, may be viewed as a mixture of an alkaline sulphate with chloride of calcium. From this it must be obvious, that when we furnish to a plant at the same time both gypsum and common salt (chloride of sodium), we actually furnish by such a solution the same materials that we would do if we supplied a mixture of sulphate of soda and chloride of calcium. In order to form the constituents containing sulphur, that element and the alkali must be retained by the plant, while the chlorine and calcium will be expelled by the roots. We know that this process actually does take place in the case of marine plants. The soda or potash is obtained from common salt or chloride of potassium, which suffers decomposition by the presence of sulphate of lime or sulphate of magnesia. It is necessary to suppose that this process also occurs with the cereal and all other plants destitute of lime. Thus we are enabled to explain the use of common salt as a manure; it enables the plant, for which this manure is useful, to extract its sulphur from the soil in which it existed in the form of sulphate of lime."

SULPHUR. An elementary substance, of a combustible and non-metallic nature. It occurs as a native mineral in the vicinity of volcanoes, in the veins of primitive rocks, and in mixture with ores of iron, copper, antimony, lead, and silver; it is obtained, for commercial purposes, from excavated sulphur pits and from the roasting of pyrites; and it is commonly cast into cylindrical moulds forming roll-sulphur, and into cones about two feet high forming loaf-sulphur, —and is afterwards purified for medicinal or other nice purposes by a process of sublimation, and is then termed sublimed sulphur or flowers of sulphur. Roll sulphur is a crystallized, brittle, solid body, of a greenish-yellow colour, and has very little taste, and emits a peculiar odour when rubbed or heated, and breaks from the heat of the hand when held in it for a short time; but it is always more or less impure, and in some instances contains an admixture of six or seven per cent. of orpiment. Sublimed sulphur is an impalpable powder, of a very bright yellow colour; and contains a minute portion of sulphuric acid, from which it can be separated by washing with water. Sulphur has a specific gravity of 1·99; and is a non-conductor of electricity; and is very volatile, within a very great range of temperature, from comparatively low to very high; and, when volatilized, condenses again unchanged in close vessels. It fuses at a temperature of 216° Fahrenheit; attains a maximum fluidity between 230° and 280°, and is then of amber colour; begins to become thick and viscid at 320°,—and if then poured into water, assumes a red colour, and has a ductility like wax, and may be kneaded into a state of eminent fitness for receiving the impressions of seals and medals; becomes so tenacious between 428° and 482° that the vessel containing it may be inverted without causing it to change its place; and from 482° to its boiling point, becomes an elastic fluid. It tends to crystallize in cooling; and generally exhibits a perceptible crystalline arrangement in the centre of the rolls; and sometimes displays an elaborate and very beautiful system of crystals in an open vessel where it has slowly cooled. It inflames in the open air at 300°, burns with a pale blue flame, and emits pungent, suffocating vapours of sulphurous acid. It is insoluble in water; but unites with it, under favourable circumstances, to form the white hydrate of sulphur, popularly called milk of sulphur. It dissolves readily in boiling turpentine,—sparingly in many oils,—and freely in a volatilized state with vaporous alcohol; and it combines with oxygen, with hydrogen, with the alkalies, and with many of the earths and metallic substances. It so obstinately retains a minute portion of hydrogen as to resist separation from it by either fusion or sublimation; and it was supposed by Sir Humphrey Davy to be, not an elementary substance, but a triple compound of oxygen, hydrogen, and a peculiar base, —and has been conjectured by other chemists to hold a similar relation to oxygen which charcoal does to carbon; but it is still regarded by the great body of chemists as truly an elementary substance, comprising a minute proportion of hydrogen in the way of an impurity.

Sulphur is an important ingredient in the nutritional principles of both animals and plants. See the articles PROTEIN and SULPHATES. It is extensively used in the arts for making sulphuric acid, manufacturing sulphates, some kinds of bleaching, and other purposes. It is used in medicine, both for internal administration by itself, and as a chief ingredient in ointments, and as a constituent of various compounds. In internal use, it is a laxative and a stimulating diaphoretic, and acts with eminent serviceableness in hæmorrhoidal affections; and in combined internal use and external application, it is a specific in scabies and some other diseases of the

skin. In veterinary medicine, it is the grand remedy for mange; and, when combined with nitre and antimony, is an excellent alterative in grease, hidebound, surfeit, and other similar diseases of the horse; and serves also as an efficient ingredient in balls for cough and fever.

SULPHURIC ACID. A compound of one equivalent of sulphur and three equivalents of oxygen. It was discovered by Basil Valentine toward the close of the 15th century; and is often though very improperly called, in popular phraseology, oil of vitriol. It naturally occurs in small quantities, concretely in the cavities of some volcanic mountains, and fluidly in some mineral waters; and it is manufactured on a large scale, for the purposes of medicine and the arts, either by subjecting protosulphate of iron to destructive distillation in close vessels, or by burning a mixture of eight parts by weight of sulphur and one of nitrate of potash in a peculiarly constructed furnace, connected with a large, leaden-walled, water-supplied, condensing chamber. The former method is the oldest, and continues to be practised in several places on the Continent, and yields a dense, oily-looking, brownish liquid, which emits copious white vapours when exposed to the air, and is commonly called fuming sulphuric acid, and has a specific gravity of from 1·896 to 1·9, and consists of two equivalents of anhydrous acid and one equivalent of water; and the latter method is practised in Britain and in most parts of the Continent, and yields a liquid which generally contains about three or four per cent. of sulphate of potash and sulphate of lead, and requires to be freed from these impurities by a process of precipitation and distillation, and is then a dense, oily-looking, colourless fluid, having a specific gravity of from 1·847 to 1·85, and consisting of about 81·54 parts of anhydrous acid and 18·46 of water. Sulphuric acid as it occurs in commerce, therefore, is always more or less hydrous; and, as it has a very powerful affinity for water, and unites with it in all proportions, it suffers the utmost possible facility of adulterating dilution; so that persons purchasing it, in any considerable quantity or for any nice purpose, require to look well to its strength; and this may, in every case, be readily ascertained by saturating a specimen with subcarbonate of soda,—every 100 grains of that salt having the power to neutralize 92 grains of the concentrated acid of specific gravity 1·848.

Sulphuric acid is one of the strongest acids known; and is terribly corrosive. It has a furiously sour taste, and exhibits in an energetic manner all the reactions characteristic of powerful acids. It combines with all alkaline substances, abstracts alkaline bases from their combination with all other acids, and carbonizes all animal and vegetable substances, with formation of water. It acquires a brown colour from the mixture of any vegetable matter,—a brown, green, or blue tint from the addition to it of a small quantity of sulphur,—a green colour from selenium,—a crimson one from tellurium,—and successively a pink and a dark reddish brown one from a minute quantity of charcoal. It freezes at 15° into six-sided prismatic crystals, bevelled at both extremities; but when diluted with water down to the specific gravity of 1·78, it freezes at 45°, or 13 degrees above the freezing-point of water,—so that at all seasons, except summer and the warmer parts of spring and autumn, it is liable, in this diluted state, to burst the bottles in which it is kept. The combination of sulphuric acid and water always evolves sudden and intense heat, and requires to be conducted with caution; for when four parts by weight of the cold acid are instantly mixed with one part of cold water, the mixture suddenly attains a temperature of 300° Fahrenheit. Sulphuric acid absorbs water so greedily and rapidly from the atmosphere as to increase its weight one-third in 24 hours, and to double its weight in a month; so that it needs to be kept in vessels with air-tight stoppers. In consequence of its powerful affinity for water, it causes the sudden liquefaction of snow, and is employed in the process of freezing water by its own evaporation, and, when mixed in due proportion with snow, generates intense cold; and probably it is the action of the same fearfully fierce affinity which constitutes its power of destroying the skin, forming ethers, and decomposing animal and vegetable substances.

Sulphuric acid has many uses in the arts,—chiefly, however, in connexion with the sulphates; and it has of late years come into extensive and important use upon the farm, in connexion with the economical preparation of bone-manure. See the article BONE-MANURE. Diluted sulphuric acid may also be employed as a means of increasing the fertility of all calcareous soils in the growth of whatever crops are benefited by the action of gypsum; for an application to such soils of a mixture of 100 parts of concentrated sulphuric acid and from 800 to 1,000 parts of water is equivalent to the application of 176 parts of gypsum. See the article GYPSUM.

SULPHURWORT,—botanically *Peucedanum*. A genus of herbaceous plants, of the umbelliferous order. The medicinal species, or hog's fennel, *Peucedanum officinale*, is a perennial-rooted indigen of the salt marshes of some parts of England. Its root comprises many strong fibres, which run deep into the ground; its stem is cylindrical, solid, striated, branching, leafy, and about 6 feet high; its leaves are repeatedly compound, and have very narrow, entire, acute leaflets; its umbels are large, and comprise numerous smooth rays; its flowers are yellow, and bloom from May till July; and its fruit is at first reddish, and afterwards assumes a tawny brown colour. This plant takes its names of sulphurwort and

peucedanum—the latter signifying "a parched pike"—from its strong, fetid, resinous smell; and its roots were formerly in request for old coughs, difficulty of breathing, deep-seated pulmonary complaints, jaundice, and obstructions of the liver, but have now lost their medicinal reputation.—Nearly twenty species, principally hardy, perennial-rooted, and yellow-flowered, have been introduced to British botanical collections from Continental Europe, Northern Asia, and other regions; but they possess little interest.

SUMACH,—botanically *Rhus*. A large and diversified genus of exotic ligneous plants, of the terebinth order. A few species have been introduced to Britain from Southern Europe and Eastern Asia; and nearly eighty from various parts of Africa and America. Three or four are creepers or climbers, a good many are upright deciduous shrubs or trees, and the rest are upright evergreen shrubs or trees; nearly twenty are hardy, seven or eight are tropical, and the rest are suited to the greenhouse or the conservatory; several are very poisonous or highly medicinal, three or four possess great or peculiar economical value, some are elegantly beautiful, and nearly all are more or less ornamental; the greater number love a soil of peaty loam, and some are propagated from seeds, some from layers, and most from cuttings. The gum-copal species has been noticed in the article Copal; and some of the most interesting of the other species may be briefly noticed here.

The poison-oak sumach, *Rhus toxicodendron*, is a poisonous and powerfully medicinal plant, and has a place in all the British pharmacopœias. It is a native of North America, and was introduced to Britain in 1640. It is a hardy, many-stemmed, decumbent, deciduous shrub, of seldom more than three feet in height. Its stems divide into slender, woody branches, and are covered with a brownish bark; its leaves are alternate, and stand on long footstalks, and comprise each three oval leaflets, angularly indented, deep shining green above, hoary below, about 3 inches long and 1½ inch broad; its male flowers rise from the sides of the stalks in close short spikes, and have a herbaceous colour, and bloom in June and July; the female flowers are larger than the male, and come out in loose panicles; and the fruit are striated berries. The leaves are the parts used in medicine. They are inodorous, and have a mawkish, subacrid taste, and yield some of their virtues to alcohol and all to water, and possess stimulating and narcotic properties, and have been used as a remedy for cramp in the stomach, herpetic eruptions, and paralysis. The infusion of them excites a sensation of heat and pricking, and causes irregular twitchings in the affected limbs of a paralytic, and is proved by its action to contain a narcotic principle, and by chemical tests to contain gum, gallic acid, resin, and tannin. An acrimonious vapour, combined with carburetted hydrogen, exhales from a growing plant of the poison-oak sumach during the night, and can be collected in a jar, and is capable of inflaming and blistering the skin of persons of excitable constitution who plunge their arms into it. A yellowish milky juice exudes from a wound or fracture in the stems of the plant; and acts as a strong poison on some persons, but produces little or no effect on others; and becomes black on exposure to the atmosphere, and then forms one of the best kinds of indelible ink for marking linen, and is used by the Japanese as a varnish. The poisonous power of the poison-oak sumach is possessed in a slight degree by most of the other sumachs, and in an eminent degree by *R. pumila*, *R. vernix*, *R. radicans*, and *R. typhina;* and both the inky and the varnishing powers are also possessed by a number of other species. Several varieties of the poison-oak sumach occur, some with hairy leaves, some with very downy leaves, and some of fine erect habit,—but all of strictly one specific character as to both structure and properties.

The tanner's sumach, *Rhus coriaria*, is a native of the Levant and of Southern Europe, and was introduced to Britain toward the close of the 16th century. It is a deciduous shrub, of commonly between 10 and 15 feet in height. Its branches are covered with a brownish hairy bark; its leaves are alternate and pinnate, and comprise each 7 or 8 pairs of leaflets, and a terminating odd one, and have a grand appearance; its leaflets are ovate, obtuse, serrated, rough or scabrous above, and villous or downy below; and its flowers come out at the ends of the branches, in large compound spikes or clusters, and have a whitish green colour, and bloom in July. The bark of this shrub is said to be as tanniniferous as that of the British oak, and to be the chief substance used in the tanning of Turkey leather; and the young shoots, ground to a coarse powder by a mill, constitute the well-known sumach of dyers,—a substance which, when used alone, imparts to wool and woollen cloth a fawn colour inclining to green, and, when used for cotton stuffs which have been previously impregnated with acetate of alumina as a mordaunt, imparts a very durable yellow. The plant is extensively cultivated in Spain and Portugal in a similar way in which osiers are cultivated in Britain, and yields a yearly harvest of young shoots to be bruised or ground for economical use; and, as it is quite hardy enough to withstand the winter in most ordinary situations in our climate, it probably would well repay somewhat extensive cultivation in our own country.

The smooth sumach, *Rhus glabra*, is a native of North America, and was introduced to Britain in 1726. It in a few years overruns lands laid down to grass in some parts of America, in the same way as furze does in Britain. It is a hardy deciduous shrub, comprising several well-marked varieties, and differing in ordinary height from 8 to 16 feet according to the variety

and the soil.—The New England smooth sumach generally attains a height of about 14 feet, and sends forth from its root and its sides many strong shoots, covered with a smooth downy bark. Its radical shoots of only one summer's growth are often an inch in diameter; its lateral shoots or young branches also are large, and have in winter a light brown colour; its leaves are larger than those of the other varieties, and comprise each ten or more proportionally large leaflets and a terminating odd one; and its flowers come out in large loose panicles at the ends of the branches, and have a greenish yellow colour, and bloom in June.—The Carolina or elegant or scarlet-flowered smooth sumach generally attains a height of upwards of 10 feet. Its branches are smooth, and have a fine purplish colour, and are dusted over with a whitish powder; and its flowers grow in panicles at the ends of the branches, and have a fine scarlet colour, and bloom in July, and are succeeded by bunches of seeds which in autumn exhibit a very beautiful red colour.—The Canada smooth sumach generally attains a height of about 10 feet. Its branches are purplish and dusted like those of the preceding; its leaflets are small on both surfaces, but are shining green above and hoary below; and its flowers grow in large panicles at the ends of the branches, and have a red colour, and appear as if a whitish powder had been dusted in among them, and bloom in July.—The berries of the smooth sumach dye a red colour, and, when boiled with the young wood, afford also a black ink-like colour; but they do not come to maturity on plants grown in Britain.

The fever or Virginian sumach, *Rhus typhina*, is a native of Virginia, and was introduced to Britain in the former part of the 17th century. It is hardy and deciduous, and comprises several varieties, which so differ in height and habit as to render it both a shrub and a tree.—The common stag's horn variety generally attains a height of about 10 feet. Its younger branches much resemble stag's horns, and are covered with a hairy down of a velvety appearance; its older branches have in some places a greyish colour, but are properly clothed with a smooth brownish bark; its leaves are pinnated and large and of noble aspect, and comprise each about seven pairs of leaflets and a terminating odd one; its leaflets are oblong, and larger than those of the tanner's sumach; its flowers come out in large tufts at the ends of the branches, and have a herbaceous colour and an inconspicuous appearance, and bloom in June; and its seeds, after the fall of the foliage at the end of the autumn, are left in large tufts at the ends of the branches, and have a scarlet colour, and make an uncommon show.—The dwarf Virginian sumach differs from the preceding only in the dwarfishness of its stature; and it seldom rises higher than 3 feet.—The large Virginian sumach shoots more strongly than the common stag's horn variety, and has a more reddish colour and a less velvety surface in its young shoots, and generally attains a height of 16 or 18 feet.—The arborescent variety commonly rises as high as 25 feet, and blooms in July and August.—The fever sumach, in at least its principal varieties, is economically valuable.

The varnish sumach, or varnish-tree, or poison-ash, *Rhus vernix*, is a native of North America and of Japan, and was introduced to Britain in the early part of the 18th century. It is hardy and deciduous, and has commonly a height of from 8 to 15 feet. It takes the epithets of poison and varnish from the properties of its milky juice, and its epithet of ash from the form and appearance of its foliage. Its branches are not very numerous; its bark is smooth, and has a light brown colour tinged with red; its leaves are pinnated, and comprise each three or four pairs of leaflets and a terminating odd one, and change in autumn to colours varying from red to purple, and make then a gorgeous show; its leaflets are oblong, pointed, entire, and, till autumn, of a fine green colour; and its flowers come out on the wings of the branches, and have a whitish herbaceous colour and an inconspicuous appearance, and bloom in summer.

Six other hardy deciduous species are the rooting, *R. radicans*, a low decumbent shrub, from North America, of similar habit and appearance to the poison-oak sumach, carrying herbaceous-coloured flowers in June and July, and comprising two varieties, the one with small fruit and the other of a twining habit; the aromatic and the sweet-smelling, *R. aromatica*, and *R. suaveolens* from North America, respectively 8 and 6 feet high, and both carrying yellow flowers in May; the wild olive, *R. cotinus*, from the South of Europe, 6 feet high, and carrying herbaceous-coloured flowers in June and July; and the hawthorn and the hawthorn-like, *R. oxyacantha* and *R. oxyacanthoides*, both from Barbary, 6 feet high, and herbaceous-colour-flowered. The greenhouse and conservatory species are chiefly upright evergreens of from 2 to 10 feet in height, and mostly from the Cape of Good Hope; and, with scarcely an exception, may be described as generally ornamental. Two of the most interesting of the hothouse species, both evergreens, are the Javanese, *R. javanica*, 10 feet high, white-flowered, and blooming in July,—and the lineated-leaved, *R. lineatifolia*, from Cuba, 2 feet high, cream-colour-flowered, and blooming from July till September.

SUMMER. The season of general inflorescence,—the warmest and sunniest of the four,—that which comprises the anti-hybernal solstice and the longest days. "There is a pleasure peculiar to spring," says Dr. Duncan, "in the contemplation of Nature rising, as it were, from the tomb, and bursting into life, and light, and joy; but that which belongs to summer is not less intense, although of a different kind. The de-

light of this season arises from the view of the full development or successful progress of the powers and processes which in Spring began to operate. The plants, which had just pierced the earth in the commencement of that season, have now shot forth their stalks, and expanded their blades, and opened their beautiful flowers to the sun; the trees rejoice in their leafy pride; the fields luxuriate in the abundance of their vegetable stores; and animated nature is instinct with life and enjoyment. The whole scene is full of delight; but it is only when it is associated with religious feelings, and when it raises the mind to a Father Being, who called all this loveliness into existence, and whose unseen presence and mysterious energies cheer and bless the world He has made, that it can be enjoyed with its highest and most appropriate relish. It is this pious sentiment which gives such sublime beauty to the 'Hymn on the Seasons;' and perhaps there is no part of that hymn which more successfully expresses the tenderness and devout admiration of a rightly constituted mind, in contemplating the wonders of Nature, than that which refers to Summer:—

'Then comes thy beauty in the summer months
With light and heat refulgent. Then thy sun
Shoots full perfection through the swelling year;
And oft thy voice in dreadful thunder speaks;
And oft, at dawn, deep noon, or falling eve,
By brooks, and groves, and hollow whispering gales.
* * * * *
Soft roll your incense, herbs, and fruits, and flowers,
In mingled clouds to Him, whose sun exalts,
Whose breath perfumes you, and whose pencil paints.'"

SUMMER FALLOW. See Fallow.

SUNDEW,—botanically *Drosera*. A genus of thalamiflorous aquatic plants, constituting the type of the natural order Droseraceæ. The species inhabit marshes or inundated lands in all the temperate regions of the world; and are remarkable for combined beauty and singularity of structure. All parts of their foliage have an abundance of glandular hairs; and their young leaves are always rolled up in the circinnate manner which is so generally and beautifully exemplified in ferns. They possess very little medicinal virtue, but in many instances have the power of coagulating milk. Five or six greenhouse species, and a dozen or upwards of hardy species, occur in British collections, and belong to five genera.

The true sundews, or plants of the genus drosera, strongly exhibit the interesting characteristics of the order, and discharge from the ends of their red glandular hairs drops of viscid acrid juice of similar appearance to dew, and possess so curious an irritability that their hairs when touched by insects contract upon them and imprison them. Three occur wild in Britain, six or seven have been introduced from North America, Southern Africa, and New Holland, and upwards of twenty more are known. The three indigenous ones are the English, the round-leaved, and the long-leaved,—the first occurring only in England and the other two both in England and in Scotland; and all three, as well as all the introduced kinds, have a height of only a few inches, and thrive only on boggy ground, and are propagated from seeds. The leaves are simple, and either undivided or lobed; and the flowers are terminal and racemose, rarely solitary, and have either a white or a purple or a white and red colour, and bloom for the most part in July and August.

SUNFLOWER,—botanically *Helianthus*. A genus of ornamental, herbaceous, exotic plants, constituting the type of a suborder of compositæ. Its involucrum is imbricated and spreads horizontally; its receptacle is flat and chaffy; and its fruit-crown has two leaf-like appendages. The suborder which it represents bears the name of Heliantheæ, and is the largest of the compositæ, and comprises about ninety genera,—among the most conspicuous, or beautiful, or best-known of which are georgina, calendula, helianthus, zinnia, sanvitalia, coreopsis, and calliopsis. Five annual species of true sunflowers, and nearly thirty perennial-rooted species, all hardy, and nearly all yellow-flowered, have been introduced to Britain; and several more are known. Most thrive in any common soil,—and the rest in a soil of peaty loam; and the annual kinds are propagated from seeds, and the perennial kinds, with one exception, by radical division. A tuberous rooted species, constituting that exception, and extensively cultivated for the sake of its esculent tubers, is noticed in the article Artichoke (Jerusalem). The name sunflower alludes either to the sun-like disc of the flowers, or to the popular but erroneous notion that they always turn toward the sun.

The common annual sunflower, *Helianthus annuus*, shares with the Jerusalem artichoke the main interest of the genus, both popular and economical. It is a native of South America, and was introduced to Britain toward the close of the 16th century, and has long been generally known and admired as a showy and staring ornament of the front of shrubberies and the back-row of broad flower-borders. Its stem is thick, strong, and branched, and usually attains a height of from 4 to 7 feet; its leaves are cordate, rough, and three-nerved; its flowers stand on strong foot-stalks, and have various shades of yellow from sulphur-colour to semi-orange, and bloom from June till October; and its heads are large and nodding, and look conspicuously both near and distant, and produce a comparatively vast quantity of seeds. Small sowings for ornamental purposes may be made in beds, at different periods, so as to obtain a long succession; the young plants, as soon as they come fairly up, should be thinned to proper distances, and kept free from weeds; and, when they attain a height of about 6 inches, they should be taken up, with

balls of earth round their roots, and planted in their final situation, and there watered till they become completely established. But the plant is eminently suited for important economical purposes, and may, in some instances, be profitably cultivated in the field. The stems form good fuel, and yield a considerable quantity of potash; and, when not wanted for these purposes, they may be either burned for manure-ashes or rotted in the dung-heap. The leaves, in either a green or a dried state, are said by some French writers to be excellent food for cows, and to be greedily eaten by them. In Portugal, the seeds are made into bread and into a kind of meal; in America, they are roasted, and used as a substitute for coffee; in all countries, they are highly relished by birds, both great and small, both wild and domestic; in various countries, they are esteemed for the expression of an oil, which is well adapted for burning in lamps, and is nearly as good as that of the olive for domestic purposes and for making soap; and in Great Britain and Ireland, they might be remuneratingly produced for the sake both of yielding the oil and of feeding poultry,—and they are said to possess the peculiar recommendations for this latter purpose of being cheap food, and of rendering hens prolific. The produce per acre will widely vary according to soil, situation, and culture, but has been found to average about 50 bushels of seed,—equal to 50 gallons of oil and about 1,500 lbs. of oil-cake; and the stems of the crop, if burnt for alkali, will yield about 10 per cent. of potash, while the leaves may be dried and pulverized and mixed with bran for fodder. The crop, however, has a very scourging effect on land, and particularly robs it of potash, and is peculiarly unsuitable for going before potatoes in a rotation. The soil most suitable is light, friable, and richly alkaline; and does admirably well to be manured with fresh sea-weed; and if loamy or clayey, may be advantageously prepared by commixations of shell sand, limestone gravel, or any other opening, calcareous substance; and, in any case, must be well tilled and finely pulverized. The situation most suitable is a moderately shady one, with sufficient exposure to enjoy free and constant circulation of the air. The sowing may be done, in a dry season, in the latter part of January,—in a wet season, about the middle of February,—in any season, in the latter part of February or at any time in March,—and in circumstances where the earliest possible crop is desired, in moderately dry weather, in October. The manner of sowing and of transplanting may be very varied; but the following has been particularly recommended: —"Let drills be drawn with a hoe or otherwise, about an inch deep, and about 18 inches asunder; sow the seed therein thinly, and cover it over an inch thick; or it may be sown by dibbling in, which is the better plan. When the fourth leaf of the young plants has sprouted, and the fifth is ready to sprout, let them all but one be removed from each place and planted elsewhere, in rows 12 or 18 inches apart, and at a distance of 10 inches in the row. Water the plants as they are put down if the weather be dry, and dry weather is essential to the success of the crop. Especial care should be directed to remove all weeds for about a month or 6 weeks, and occasionally to mould up the earth around each plant." When the heads are quite or nearly ripe, the plants should be cut down at about an inch from the ground, and removed to a shed or some other place of complete shelter from rain, and there left till they become dry; and either then or afterwards, they may be freed from the seed; but they must not, in any case, be left on the ground, as they have a great capacity for moisture, and would be very likely to attract it and to become filled with insects.

The dwarf Indian sunflower, *Helianthus indicus*, possesses similar properties to the common annual sunflower, and may be cultivated for the same purposes, and in a similar way. It is also an annual, and blooms throughout the same period; but it is less branched, and smaller in all its parts, and has only about half the height, and is of a lighter yellow colour in its flowers. It was introduced from Egypt in 1785.—The tube-formed sunflower, *Helianthus tubæformis*, is an annual of rather less height than the common sunflower, and blooms during a much shorter period. It was introduced from Mexico in 1799. —The showy sunflower, *Helianthus speciosus*, is an annual of about the same height as the preceding, and carries red-coloured flowers from September till November. It was introduced from Mexico in 1833.—The perennial fibrous-rooted sunflowers vary in height from 2 to 10 feet; and all have yellow flowers, and are natives of North America.

SUN-ROSE, — botanically *Helianthemum*. A genus of ornamental plants of the cistus family. They are very nearly allied to the true cistuses in botanical characters, and closely resemble them in eminent adaptation to the covering of rock-work. The great majority have a golden or sun-like colour of flowers, varying from pale yellow to copper-colour; and they derive from this circumstance both the popular name sun-rose and the botanical name helianthemum or 'sunflower.' Seven species grow wild in Britain, and considerably upwards of one hundred have been introduced from other countries. About a dozen are hardy annuals; a few are hardy herbaceous perennials; a large number are hardy, evergreen, trailing or procumbent undershrubs; a few are hardy, evergreen, erect undershrubs; and most of the remainder are frame, evergreen, erect undershrubs and shrubs. The annual and herbaceous kinds are propagated from seeds, and the ligneous kinds from cuttings. The great majority of the species, of whatever kind, love a soil of sandy peat, and bloom in June and July.—One subgenus comprises about sixteen erect, evergreen

shrubs of from 1 foot to 6 feet in height, all exotic, one or two of them hardy, and the rest somewhat tender; and its sepals generally amount to three, but sometimes to five,—its petals are very often spotted at the base,—and its stigmas are capitate and subtrilobed. The umbel-flowered species, *H. umbellatum*, belonging to this group, is particularly handsome, and has white flowers. It was introduced from the South of Europe in 1731; it comprises two varieties,—the erect and the subdecumbent; and it has a height of about 2 feet, and blooms from June till August.—Another subgenus comprises three hardy herbaceous perennials, one hardy evergreen undershrub, and three more or less tender evergreen undershrubs,—and almost all about 10 or 12 inches in height; its sepals, as also those of all the remaining subgenera, amount to five,—its outer sepals are linear,—its stigmas are large and capitate,—and its capsules are smooth, three-valved, and three-celled.—A third subgenus comprises five hardy annuals, one hardy undershrub, and three herbaceous perennials,—almost all about 6 or 8 inches in height; and its outer sepals are variable in size,—its petals are often spotted at the base,—its styles are scarcely perceptible,—and its stigmas are capitate. The spotted-flowered sun-rose, *H. guttatum*, a species belonging to this group, is an annual indigen of the sandy pastures of some parts of England.—A fourth subgenus comprises seven or eight hardy annuals, varying in height from 3 to 14 inches; and its outer sepals are very small,—its petals are small and often spotted at the base,—its stigmas are simple,—and its capsules are triquetrous. The ledum-leaved species, *H. ledifolium*, belonging to this group, is an indigen of the sandy pastures of some parts of England, and has a height of about 6 inches.—A fifth subgenus comprises four or five exotic evergreen undershrubs, principally about a foot in height, and most of them erect; and its sepals have a silky exterior,—its outer sepals are very small,—its styles are twisted at the base,—and its capsules are pilose or woolly.—A sixth subgenus comprises about a dozen erect, exotic, evergreen undershrubs, of from 6 to 25 inches in height; and its calyx, in the early stages of development, is twisted,—its outer sepals are small,—and its stigmas are capitate and trilobate.—A seventh subgenus, so similar to the true rock-roses as to be called pseudocistus, comprises eight or nine trailing evergreen undershrubs, and about the same number of erect ones,—most of the former hardy, and most of the latter somewhat tender; and its outer sepals are very small,—its petals also are small,—its styles are twisted at the base,—and its stigmas are capitate and trilobed. The marum-leaved species, *H. marifolium*, a hardy, evergreen trailer belonging to this group, is a native of the rocky portions of some of the lofty mountains of Britain.—An eighth subgenus, so eminently exhibiting the proper characteristics of the sun-roses as to be called euhelianthemum, comprises all the rest of the genus except one anomalous species, and is therefore much the largest subgenus, and consists in a main degree of hardy trailing evergreen undershrubs,—most of which have a height of from 4 to 10 inches; and its outer sepals are small,—its stigmas are simple,—and its capsules are three-valved and one-celled. The common sun-rose, *H. vulgare*, belonging to this group, is an indigen of the grassy banks and calcareous hills of many parts of Britain, and is one of the best known species even in gardens, and may be regarded as a good and fair specimen of the whole genus. Its stems are slender and leafy, and extend trailingly to the distance of nearly a foot in various directions; its leaves are small, oblong, dark green above, and greyish below; its flowers come out at the end of the stems in loose spikes, and have a deep yellow colour, and spread open during the day, but shut close in the evening, and bloom from May till September; and its capsules are roundish, and enclose many angular seeds. Double-flowered varieties occur in gardens, with respectively common yellow flowers, dark yellow flowers, large dark yellow flowers, blood-coloured flowers, and variegated leaves. Three other indigenous species belong to the same group,—the tomentose, *H. tomentosum*, a trailer of the Scottish Highlands, with larger stems than the common sun-rose, carrying yellow flowers in July and August; the polium-leaved, *H. polifolium*, a trailer of the downs of England, with stems about 6 or 8 inches long, carrying white flowers from May till July; and the Surrey, *H. surrejanum*, a trailer of the chalk hills of the south of England, with stems nearly a foot long, carrying yellow flowers from July till October.

SUPPURATION. The process of forming purulent matter under certain kinds of inflammatory action. See the articles PURULENT MATTER and INFLAMMATION.

SURBATING. Inflammation of the horse's foot. See the article FOOT.

SURFACE DRAINING. See DRAINING.

SURFEIT. A disease of the horse's skin, consisting in the eruption of scabs or small pustules, notwithstanding all due attention to cleanliness and grooming. It seems to arise from a diseased state of the stomach and the intestines; and in every ordinary case, it ought to be attacked with alternately a mild purgative and an alterative, accompanied by the use of warm clothing,—and in a very bad or stubborn case, it should be further treated with bleeding and aloetic physic,—and, if it do not give way to these remedies, it may be regarded as the precursor or covering of a worse malady. See the article MANGE.

SURVEYING. See LAND-SURVEYING.

SUTHERLANDIA. An ornamental, evergreen, Cape-of-Good-Hope shrub, of the lotus division of the leguminous order. It constitutes a genus of

itself, and is specifically called the frutescent; but it is nearly allied to the bladder-sennas, and was ranked as such by Linnæus. It was introduced to Britain so long ago as the latter part of the 17th century; and it is but slightly tender. It has a height of about 3 feet, and carries scarlet flowers in June and July; and it loves a soil of sandy loam, and is propagated from seeds.

SUWARROW NUT. See Butter Nut.

SWAD. A pod or legume. The word is provincial.

SWAINSONIA. A genus of ornamental, evergreen, small, Australian shrubs, of the lotus division of the leguminous order. Two species with purple flowers, and two varieties of another species with respectively red and white flowers, all about 2 feet high, and blooming in July and August, have been introduced to British gardens. They love a soil of sandy peat, and are propagated from seeds.

SWALLOW,—scientifically *Hirundo*. A genus of birds of the fissirostrous family of passerinæ. In a large sense, it comprises all the diurnal species of that family; and in even a smaller sense, it comprises not only the common swallow, but also the martin, the sand martin, and the salanganes. The bill of all, in common with that of other fissirostres, is short, broad, horizontally flattened, slightly hooked, and unemarginate, and has an extended commissure, so that the opening of the mouth is very large, and possesses eminent adaptation to the catching and swallowing of insects while the birds are on the wing.

The common or country or chimney swallow, *Hirundo rustica*, is a well-known, regular, very numerous, and very useful visitor of Britain, and of many other lands. Its total length is 8½ inches; its outside tail-feathers are very elongated, and measure nearly 5 inches; its general plumage is slate blue and dull black; its forehead, eyebrows, and throat are red or chestnut; and some parts below are pure white. It feeds entirely on winged insects, and hunts them through the air during the greater portion of the day, and has such power of flight as to pursue its prey for hours in succession without any apparent fatigue. It builds in chimneys and similar places, and forms its nest of moistened earth or clay mixed with bent and straw, and lined with feathers. Its eggs amount to four or six, and have a white colour speckled with ash and dark red, and measure 9½ lines in length and 6½ in breadth.

Swallows are controlled in the period of migration by the temperature of the season and the state of the wind; but, on the average, they arrive in Britain about the 10th of April, and depart about the middle or latter part of October. They come gradually or in small and successive numbers, but go away in vast flocks, leaving only a few stragglers behind. On the coast between Orfordness and Yarmouth, they assemble in swarms in October, covering the church-leads and the naked branches of trees; and they are then preparing to depart from the tract of coast whence emigration is easiest to their winter-retreats, and they are evidently wind-bound, for they abide in their gathering-place till the wind veers to the north-west or some other favourable point,—and if this happen in the night, they so suddenly and entirely disappear that not a swallow can be seen in the morning.

Swallows are a very useful race of birds, and relieve us from innumerable noxious insects which infest our atmosphere and prey upon our crops. "Whoever contemplates the myriads of insects that sport in the sunbeams of a summer evening will soon be convinced to what a degree our atmosphere would be choked by them, were it not for the friendly interposition of the swallow tribe. Such would-be marksmen as shoot at swallows should recollect that these birds are seen only during the breeding months in summer, and that by shooting the old ones the nestlings in consequence perish. Minute observers calculate that one of these birds destroys daily hundreds of gnats, flies, moths, and other insects, parents of the swarms of gnats and caterpillars which strip our gardens, and commit such waste upon vegetation in general. These birds, therefore, should be considered as little messengers of Providence, and as instruments without whose assistance the plough and the spade would often be ineffectually employed. In almost every village in America, they are held in the same sort of veneration as the Egyptians show to the ibis of the Nile; the villagers place small square boxes,—some of them prettily adorned and painted,—to induce these strangers to sojourn and peaceably enjoy their months of incubation. The late Dr. Franklin used to say,

"Be kind to the swallow,
And profit will follow."

SWALLOW-WORT,—botanically *Asclepias*. A genus of ornamental exotic plants, constituting the type of the natural order Asclepiadeæ. This order is noticed in the article Asclepias. The calyx of the swallow-wort genus is five-cleft, small, and persistent; the corolla is monopetalous, flat or reflexed, with a five-leaved crown, and a process on the inside; the pollen-masses are fixed by a fine end; and the stigma is depressed and blunt. About 40 species have been introduced to Britain from other countries,—principally North and South America; about 30 more are known; and a good many which formerly belonged to it, and have been introduced to Britain, are now assigned to nine other genera. The swallow-worts are remarkable for curious beauty; and several are economical and medicinal. Most of those in British collections are erect, perennial-rooted, annual-stemmed herbs; but a few are either tuberous-rooted or evergreen herbs or twiners. The majority are hardy; and the rest belong variously to the greenhouse and the hothouse. All, with a few exceptions,

have either purple, red, or white flowers; and the greater number are most readily propagated by radical division.

The Syrian swallow-wort, Virginian swallow-wort, or Virginian silk, *Asclepias syriaca*, is a native of North America, and was introduced to Britain in 1629. Its roots are creeping and perennial; its stems are annual, erect, unbranched, and from 4 to 6 feet high; its leaves are opposite, oval, thick, and downy below; its flowers come out in nodding umbels from the junctions of the leaves and stem, and have a purple or dull reddish colour, and bloom in July and August; and its pods are long and nearly upright, and have a rough coriaceous skin, and contain thin membranous-edged seeds, thickly covered and profusely enveloped with a white down of similar appearance to cotton. The flowers are highly fragrant, especially in the morning and the evening, and are gathered in their native country while the dew is on them for the purpose of making sugar; the young shoots, in spring, are a very good substitute for asparagus; the down of the pods serves well for stuffing pillows and cushions, for making thread and cloth, and for some other purposes; and the fibrous matter of the stems is abundant in quantity, and excellent in flax-like quality, and is used and highly appreciated in some parts of North America for making thread, cordage, fishing-nets, and cloth. The plant accommodates itself to a great variety of soils and situations, and has been successfully experimented with as an agricultural plant in France, and may probably be well worthy of field cultivation in some parts of Britain. It may be propagated by either sowing seeds or transplanting roots in rows about two feet apart; it must, of course, be kept clean from weeds; it gradually fills the intervals between the rows by the creeping of its roots, and arrives at full maturity in the third year after sowing; it might be combined in culture, during the first and second year, with some annual crops which should occupy the vacant spaces previous to its maturation, and it will continue in full vigour and maintain entire occupancy of the soil during a considerable number of years. The soil most suitable for it is rather moist, of medium texture, and of medium fertility.

The principal medicinal swallow-worts are the curassoa, *A. curassavica*, a tropical, perennial-rooted, annual-stemmed herb, of about 3 feet in height, carrying scarlet flowers from June till September, but comprising also a white-flowered variety, and introduced from South America toward the end of the 17th century; the asthmatic, *A. asthmatica*, a tropical twiner of about 8 feet in height, carrying white flowers in July and August, and introduced from Ceylon in 1810; the antidotal, *A. alexiaca*, a tropical twiner, of about the same height as the preceding, with herbaceous-coloured flowers, introduced from Ceylon in 1816; and the decumbent, *A. decumbens*, a hardy tuberous-rooted herb, of about 2 feet in height, carrying orange-coloured flowers in July and August, and introduced from North America in 1731. Their chief medicinal properties are emetic and sudorific. See the article Ipecacuan.

Among the most ornamental species are the pleasing, *A. amœna*, fibrous-rooted, purple-flowered, and about 3 feet high; the variegated, *A. variegata*, fibrous-rooted, white-flowered, and about 4 feet high; the whorl-leaved, *A. verticillata*, fibrous-rooted, white and green flowered, and about 3 feet high; the acuminate, *A. acuminata*, fibrous-rooted, red and white flowered, and about 2 feet high; the tuberous, *A. tuberosa*, tuberous-rooted, orange-flowered, and about 2 feet high; the roseate, *A. rosea*, herbaceously evergreen, red-flowered, and about 1 foot high; and the flax-leaved, *A. linifolia*, herbaceously evergreen, white-flowered, and about 3 feet high;—all from North America, most blooming in July and August, the first five hardy, and the other two suited to the greenhouse.

SWAMP. Moist and soft land akin in character to a marsh or a bog, but differing from both in producing shrubs and trees. See the articles Marsh and Bog.

SWAN,—scientifically *Cygnus*. A group or subgenus of the duck tribe of lamellirostrous palmipedes. They are the largest birds of the tribe; and are distinguished internally by comparatively long intestines and cæca, and externally by a very long neck, and by a bill of equal length throughout, higher at its base than it is wide, with the nostrils about the middle of its length.

The tame or domestic or red-billed swan, *Cygnus olor*, is the species which, when domesticated, forms the finest living ornament of our ponds and water-scenery. It is larger than the wild swan, and may readily be distinguished from it by its bill,—which has a red colour, edged with black, and surmounted at the base by a black rounded protuberance or callous knob. The general plumage of the bird is snow-white. A cygnet or young swan of its species, however, has a lead-coloured bill and grey plumage. The domestic swan figures nobly before every eye, and is admired alike by the rustic and the poet, by the child and the philosopher; and, in joint virtue of the elegance of its form, the gentleness of its motions, and the brilliant whiteness of its plumage, it is a fit emblem of beauty and innocence. It feeds indifferently on vegetables and fish, eats alike bread, seeds, and succulent parts of plants, is capable of such familiar domestication as to feed from the hand, and requires artificial supplies of food, and also artificial assistance in the breaking of ice and the keeping of ponds open, during the severe parts of winter. It flies at a great elevation, and with considerable rapidity; and it swims swiftly, and employs its wings both as sails for moving before the wind, and as pow-

erful weapons for striking down any enemy by whom it is attacked. The female breeds only once a-year, and lays in summer from five to six eggs. She prefers an islet as her breeding-place for sake of its quiet; and forms her nest by a simple surface deposition of a little straw; and sits about a month if the weather be fine, and longer if it be coarse. The young ones remain with her nearly a year; but are driven away by the old cob or male bird at the approach of the next breeding season; and they do not attain their full plumage till the third year. The cob is larger and bolder than the female; and two pairs seldom live peaceably or profitably together on the same pond or lakelet. The old birds often take a fancy to fly away at the fall of the year; and when not very perfectly domesticated, they require to be kept from roving by having the first joint of one wing removed. The domestic swan hisses when angry, and has a peculiar kind of snort, but no voice; and is therefore sometimes called the mute swan.

The wild or whistling or black-billed swan, called by Linnæus *Anas cygnus*, comprises several varieties or subvarieties, some one or more of which have frequently been mistaken for distinct species. It has a length of about 5 feet, and a breadth of about 7 feet, and weighs from 14 to 17 pounds. Its bill is three inches long, and has a yellowish-white colour from the base to the middle, and a black colour from the middle to the end; its legs are black; its skin is clothed beneath the plumage with a thick fine down; and its general plumage, in the case of every full-grown individual, is either a perfectly pure white or a white tinged with yellowish-grey. It is externally very similar to the tame swan, but internally very different,—for its trachea bends over and penetrates to a considerable extent in a cavity of the keel of the sternum; and it owes to this configuration the power of uttering a wild shrill note when flying or calling; but it performs no melody,—and the old story of its singing on the approach of death is a fable. "Wild swans," we are told, "are inhabitants of the northern regions, never appearing in England but in hard winters, when troops of five or six are now and then seen. Martin says, that in October, swans come to Lingay, one of the Western Isles, in great numbers, and continue there till March. A few stay in Mainland, one of the Orkneys, and breed in the little islands of the fresh water lochs; but the principal part of them retire at the approach of spring, and are considered the countryman's almanack, the inhabitants expecting a mild spring, when their departure is early. In countries where they may be considered as natives, they generally keep together in small flocks, except in the pairing season, or at the setting in of winter; at the latter period they assemble in immense throngs, particularly in the extensive rivers and lakes of the thinly inhabited northern part of Europe, Asia, and America. At the commencement of frost the wild swans are said to associate in prodigious multitudes, and, thus united, to use every effort to prevent the water from freezing, by constantly dashing it with their extended wings; and by this means are enabled to remain in some favourite part of a lake or river which abounds with food, so long as it suits their convenience; but when the severity of the weather threatens to become insupportable, high in air, in divided and diminished numbers, they shape their course in search of milder climates; and in such seasons they are most commonly seen in various parts of the British Isles, and in other more southern countries of Europe. In their flight the swans follow so closely that the bill of the one lies upon the tail of the other. The great bodies of them are, however, met with in the large waters near Hudson's Bay, and those of Kamtschatka, Lapland, and Iceland. They are said to return to the latter place in flocks of about a hundred at a time in the spring; and also to visit that island from the north in nearly the same manner, on their way southward in the autumn. In Iceland these birds are objects of chase, losing their feathers in August, so as to be unable to fly. The natives at that season come provided with dogs, and active horses, capable of passing nimbly over the boggy soil and marshes, where they most resort. The swans will puzzle a tolerably quick horse to overtake them; but the greater numbers are caught by the dogs, that are taught to seize them by the neck, which causes them to lose their balance, when they become an easy prey. Many are likewise shot and killed with clubs. The Icelanders compare the voice or cry of the swan to the notes of a violin; they hear it at the termination of their long and gloomy winter, when the return of the swan announces the return of summer; every note, therefore, must be melodious which presages a speedy thaw, and the release from their tedious confinement. The flesh is highly esteemed by the Icelanders (especially that of the young birds), insomuch that, summer or winter, no entertainment is deemed complete without a swan. Their eggs, of which they lay four, and hatch them in July, are also considered delicious food. The Icelanders, as well as the Kamtschatdales, and other natives of the northern world, dress their skins with the down on, sew them together, and make them into garments of various kinds; and the covering of the legs taken off whole is used for purses, and appears not unlike shagrin. The northern American Indians employ the skins in similar uses, and sometimes weave the down as barbers weave the cauls for wigs, and thus manufacture it into ornamental dresses for the principal women of rank, while the larger feathers are formed into caps and plumes, to decorate the heads of their chiefs and warriors. They also gather the feathers and down in large quantities, and barter

them with the traders of more civilized nations. The swan is with propriety termed 'the peaceful monarch of the lake.' Conscious of his superior strength, he suffers not even the eagle to molest him. His vigorous wing is as a shield against all attacks; and the blows from it are said to be so powerful as to stun or kill the fiercest of his foes. The wolf or the fox may surprise him in the dark; but in the day their efforts are fruitless. His food, like that of the tame swan, consists of the grasses and weeds, and the seeds and roots of plants which grow on the margins of the water,—of the myriads of insects which skim over, float upon, or are found beneath its surface,—of frogs, and, it is said, occasionally (but this wants confirmation) of the inhabitants within its bosom. Swans are certainly detrimental to fish from their dung, when the water upon which they are kept is shallow, and no stream runs into, to freshen it; and they are with some reason believed to destroy the spawn of trout, by stirring up the gravel, and of other fishes by rooting up the weeds on which many kinds deposit their ova; but of their directly preying on the spawn, or the small fry lately excluded from it, there is no positive evidence."

SWANWORT. See Cycnoches.

SWARD. The surface of grass land. It widely varies in thickness, texture, and luxuriance according to soil, situation, management, and the kinds of the herbage; but, in a general view, the sward of Britain is finer and greener and more velvety than that of any other European country, not even excepting Ireland, and may be regarded as a grand and beautiful characteristic of British landscape, and as owing its superiority, not alone to the peculiar nature of our climate, but in some degree also to the comparatively enlightened and assiduous attention which Britons give to lawns and pasturage. See the article Grass Lands.

SWARM. See Bee.

SWARTH. See Swath.

SWARTZIA. A genus of ornamental, evergreen, exotic shrubs, constituting, with the genus baphia, the small non-papilionaceous suborder of curvembrious leguminosæ. See the article Leguminosæ. Three species, all about 6 feet high, all loving a soil of peaty loam and propagable from cuttings, two of them white-flowered and the other yellow-flowered, have been introduced to British gardens from the West Indies; and about a dozen more are known.

SWATH, or Swarth. A layer of mown grass or other mown crop deposited by the scythe. See the article Mowing.

SWEALING. The singeing of hair, or burning of it off, as is done in the case of hogs.

SWEAT. See Perspiration.

SWEDE, or Swedish Turnip. See Turnip.

SWEET ACORN. See Acorn and Oak.

SWEET BAY. See Laurel.

SWEET BREAD. See Pancreas.

SWEET BRIAR. See Briar (Sweet).

SWEET FLAG. See Acorus.

SWEET GALE. See Candleberry Myrtle.

SWEET GRASS. See Glyceria.

SWEET GUM. See Liquidambar.

SWEETIA. A genus of ornamental, twining, evergreen, purple-flowered, tropical plants, of the kidney-bean division of the leguminous order. Three species, the woody, the long-leaved, and the thread-shaped, varying in height from 3 to 6 feet, have been introduced to British collections from South America and the West Indies; and they love a soil of sandy peat, and are propagated from cuttings.

SWEET LEAF. See Symplocos.

SWEET MARJORAM. See Marjoram.

SWEET MAUDLIN. See Milfoil.

SWEET PEA. See Lathyrus.

SWEET POTATO. See Battatas.

SWEET-SCENTED VERNAL GRASS. See Anthoxanthum.

SWEET SULTAN. See Centaurea.

SWEET WILLIAM, — botanically *Dianthus Barbatus*. A well-known, hardy, ornamental, evergreen, herbaceous plant, of the pink genus and carnation family. It was introduced to Britain from Germany in 1573, and has long been one of the most generally diffused and universally admired beauties of the British parterre. It is often so carelessly and exhaustingly cultivated in the flower-plots of the poor and the ignorant as to have a decumbent habit and a slender and sickly appearance; but, in its proper character, and with ordinarily good treatment, and when not in extreme old age, it has a bold stem, and stands firmly erect, and has a height of from 12 to 20 inches, and shows a great profusion of the most brilliantly tinted flowers. It comprises multitudes of varieties, which differ from one another in the height of the stem, the breadth and form and colour of the leaves, the nature or aggregation of the inflorescence, the form and singleness or doubleness of the flowers, and especially the ground-colour and variegations and markings of the petals; and it commonly brings out very many of these varieties, or exhibits great and beauteous sportiveness of character, from a single sowing of even one specimen of seeds. The narrow-leaved kinds were formerly called Sweet Johns, and only the broad-leaved kinds Sweet Williams; but the two groups were soon found to be interchangeable with one another from sowings, and the distinction between them was abandoned. Some of the single flowers have very rich colours, and often vary from one another in the same bunch; and some are most lusciously variegated or exquisitely traced and marked with minute tintings; while others, popularly called painted ladies, have a soft red centre and a delicately white border. Very fine kinds may, in some degree, be perpetuated as well as endlessly diversified and sometimes improved, by completely clearing them from the vicinity of all inferior sorts, so that they may be im-

pregnated only by one another's own pollen. The single kinds are propagated from seeds, and the double kinds from layers. Seeds must be saved from select plants in August, and sown on a bed of light earth about the end of March or beginning of April; the seedlings must be planted out, in June, into prepared beds, at distances of about 6 inches; and the young plants should be transplanted in October to their final situation, where they will bloom in the following June and July. The layers of the double kinds are managed in the same way as those of carnations. A method of propagating sweet williams by slipping their roots at Christmas is often practised; but it is coarse and very degenerating, and nearly as troublesome as the proper methods.

SWELLED LEGS. Acute inflammation of the cellular substance of the legs of horses, accompanied with the effusion of fluid into the cellular membrane. It is very varied in symptom, and still more varied in cause; and occurs oftener in working horses than in saddle ones, and oftener in the hind legs than in the fore legs. It sometimes appears as a sudden and violent and enormous swelling from the hock to the fetlock, accompanied with heat, tenderness, considerable feverishness, and a very peculiar lameness; and in this form, it attacks principally young horses who have been pampered with food and not duly exercised,—and must be treated with fomentations and physicking, and, if necessary, with moderate bleeding. It sometimes appears as a sudden and prodigious swelling, with little or no accompanying lameness, or as a vast gorging of the limbs, with very great accompanying pain and stiffness, or as a kind of simple chronic swelling, tending to abscess and eventually to grease; and in these forms, it is often troublesome and refractory, and must be treated with purgatives and diuretics, and, if the animal be in high condition, with also moderate bleeding. But the disease sometimes has different characters from these, and arises from widely different and even totally contrasted causes,—such as fitfully irregular work, alternations of violent exercise and none, difficulty in the seasonal moulting of the coat, and even downright starvation; and in all these cases, it must be treated with means of renovation and strengthening, such as mild diuretics, tonics, cordials, and hand-rubbing,—varied and modified in adaptation to the special causes and symptoms.

SWERTIA. See Felwort.

SWIETENIA. See Mahogany.

SWIFT. Birds of the martin or martinet group. See the article Martin.

SWINE. See Hog.

SWINE-CRUE. A hog's sty.

SWINE'S CRESS. See Wart Cress.

SWINE'S SUCCORY,—botanically *Hyoseris*. A genus of hardy, yellow-flowered, exotic, herbaceous plants, of the succory division of the composite order. Two annual species, and two perennial-rooted ones, all about a span high, thriving in any common soil, and blooming in the latter part of summer, have been introduced to Britain from the sea-boards of the Mediterranean; but they possess little interest.

SWINGLE-TREE. See Plough.

SWING-PLOUGH. See Plough.

SWITCHING. Lopping off the salient branches, protruding twigs, and exuberant points of a hedge, so as to clear it of all straggling growth, and reduce it to regular dimensions. The implement with which this operation is performed is called a switching-bill; and has a curved blade of about 9 inches in length and 1½ inch in breadth, fixed elongatedly on a haft of about 2¼ feet in length; and is used with a stroke directed upward and inclined backward. See the article Hedge.

SYCAMORE. See Maple.

SYMPHORIA. See Saint Peter's Wort.

SYMPHYTUM. See Comfrey.

SYMPLOCOS. A genus of ornamental, evergreen, corolliflorous, exotic shrubs, constituting the small natural order Symplocineæ. It is nearly allied to the epacris and the storax orders. The leaves of all the species are serrated and become yellow in drying,—and those of most are astringent; and the flowers of all are white or yellow, and of small size,—and those of some are fragrant. The dyer's or laurel-leaved species, *S. tinctoria*, is a native of Carolina, and was introduced to Britain in 1780. It has a height of about 3 feet, and carries yellow flowers, and is propagated by layering. Its foliage, under the name of sweet leaf, is used by the Americans for yielding a yellow dye.—The Chinese species, *S. sinica*, was introduced from China in 1822; and it has a similar height to the preceding, and carries white flowers in May, and is propagated from cuttings.—Both species love a soil of peaty loam.

SYNAPTAS. A peculiar nitrogenous substance which cannot be preserved when dissolved in water. The solution of it speedily becomes turbid, and deposits a white precipitate, and acquires an offensive putrid smell.

SYNGENESIA. See Botany.

SYNNOTIA. A small genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. Three species, the variegated, the two-coloured, and the helmeted, the first and second about 6 inches high, the third about a foot high, and all blooming in spring, have been introduced to the greenhouses of Britain. They are akin to the ixias and the gladioli; and they love a mixed soil of sand and peat and loam.

SYNOVIA. The mucilaginous secretion which lubricates the joints of animals, and is popularly but erroneously called joint-oil. It has a consistency similar to the fluid white of an egg, and seems to be secreted by the vessels of the capsular ligaments, and, when secreted in excess, constitutes capsular dropsy. See the article Rheumatism.

SYRINGA. See Lilac and Philadelphus.

SYRUP. A saturated solution of sugar. It may be either simple, as a mere form or variety of sugar itself; or flavoured with essential oils or fragrant vegetable substances, as a liquid confection; or impregnated with any one or more drugs capable of thoroughly combining with it, as a compound medicine. Many syrups figure in the pharmacopœias; but, with a few exceptions, they might be very advantageously substituted by infusions, decoctions, tinctures, or some other ordinary forms of exhibition. Sugar can serve at best as only a means of modifying the nauseousness of drugs combined with it,—and to some palates it rather heightens that nauseousness than decreases it, while to few or none can it conceal it so well as some other plain and common accompaniments would do. All syrups should be clarified by means of a little white of egg beat into a froth, and should have a specific gravity of 1·385 when cold; but, however carefully and exactly made, they are liable to ferment and become asescent in a temperature above 60° Fahrenheit,—and if they be not well boiled and have not enough of sugar, they will ferment in almost any ordinary circumstances,—while, if they contain an excess of sugar, they will speedily undergo crystallization of part of it and spoiling of the rest.

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TABACUM. See Tobacco.

TABERNÆMONTANA. A genus of ornamental, evergreen, ligneous, tropical plants, of the dog's-bane tribe. Upwards of a dozen species, varying in height from 4 to 45 feet, mostly carrying either white, yellow, or cream-coloured flowers, and all loving a soil of rich mould and propagable from cuttings, have been introduced to the botanical collections of Britain; and upwards of twenty more are known. See the article Nerium.

TABES. A morbid wasting of live trees. It is indicated by sickliness of colour, diminution of foliage, and the gradual consuming of the branches; and it is caused sometimes by parasitical plants, and sometimes by spontaneous bleeding or great loss of sap. When it is caused by ivy, it may be arrested by an early and prompt eradication and removal of the parasite; when by mosses and lichens, it may be mitigated by topical applications of caustic lime water; and when by bleeding, it may sometimes but not often be arrested by dressing wounds, closing apertures, and promoting by every possible means the healthiness of the branches and the luxuriance of the foliage. But all trees ought to be protected from choking attacks of parasites by timely thinning and pruning, and by the free admission of air and light; and full-grown timber trees, especially elms, attacked by tabes from loss of sap, may most profitably be cut down at once, and used for timber, without incurring the risk of further progress of the disease.

TACAMAHACA. See Balsam-Poplar.

TACCA. A genus of curious-looking, herbaceous, tropical plants, of the order aroideæ. The pinnatifid species, *T. pinnatifida*, is a native of India and other eastern countries, and was introduced to British collections in 1793. It has a height of about 2 feet. Its root is bulbous; and is used as an esculent in China, Cochin-China, Banda, India, and some parts of Polynesia. It possesses a considerable degree of acrimony, and requires to be frequently washed in cold water before being dressed. In some places, it is eaten in substance with some agreeable acid or other condiment to subdue its natural pungency; and in others, it is ground into meal, and baked into a sort of gelatinous bread, similar to that made from salep. Four other bulbous-rooted species, chiefly about the same height as the pinnatifid, and all carrying brown flowers in July and August, have been introduced from India and Mauritius; and all the five species love a soil of loamy peat, and are propagated by division of the root.

TACSONIA. A genus of ornamental, exotic plants, of the passion-flower family. They are nearly allied to the true passion-flowers, yet may readily be distinguished from them by the long tube of their corolla. See the article Passion-Flower. They are well adapted to the conservative walls of gardens; and may be made to produce there a succession of their magnificent flowers from July or August till the commencement of frost.—The softest species, *T. mollissima*, is a climbing shrub of considerable height, with downy stems and stalks, serrated, trilobate leaves, ovate-lanceolate leaf-lobes, and axillary, solitary, downily-peduncled flowers,—each flower comprising a long green tube and five calycine and five petaline segments, forming together ten nearly equal divisions, all of a lively rose colour.

TADPOLE. The young produced from the

eggs of the frog, which is extremely unlike the animal in its perfect state, seeming to consist only of a head and tail. The head is large, black, and roundish, the tail slender, and margined with a broad, transparent fin. Its motions are very lively. Its food consists of small water plants and different animalculæ. The mouth has very minute teeth. About five or six weeks after it is hatched, the first change takes place. The hind legs first appear, and gradually increasing in length and size, are succeeded, in about two weeks, by the fore legs, which are formed at an earlier period beneath the skin. The tail now decreases, so that, in a day or two, it is quite obliterated. After this change the animal leaves the water, and covers the shores in myriads. The sudden appearance of such multitudes of young frogs has probably induced the popular but groundless belief of their having fallen from the clouds in showers. It has now become a perfect frog. Tadpoles, just after they are hatched, are perfectly transparent; and, when placed before the double microscope, the pulsation of the heart may be easily seen, and the blood protruded thence may be observed in its passage through the whole body.

TÆNIA. See Worms (Intestinal).

TAG. A sheep of the first year.

TAGETES. A genus of hardy, ornamental, exotic, annual plants, of the jacobea division of the composite order. Fourteen species have been introduced to Britain from Mexico and South America; and all thrive in any common soil, and are propagated in the ordinary manner of hardy annuals. One, *T. lucida*, has entire leaves, and all the others have pinnate or bipinnate leaves; one, *T. patula*, has variegated flowers of yellow, orange, and blood-colour, and all the others have yellow flowers; two, *T. lucida* and *T. corymbosa*, have a height of less than 20 inches, and most of the others have, or may have, a height of about 2 or 3 feet; two, *T. patula* and *T. erecta*, are among the most common and most highly admired beauties of the annual flower-border, and have been described, under their popular names, in the articles African Marigold and French Marigold, and most of the others are more or less worthy of abundant diffusion. The slender-leaved, in particular, *T. tenuifolia*, may be selected as well deserving to compete with the two old favourites. It was introduced from Peru in 1797; and is noticed as follows in one of the florist periodicals of 1845:—"It is one of the best annuals for bedding out with which we are acquainted. The plant forms a dense compact mass of small twiggy branches, having numerous, slender, pinnatifid leaves, and a profusion of moderate-sized orange-yellow, marigold-shaped flowers. The leaves are curiously marked with a row of what appear to be minute orange-coloured dots, but which are in reality minute glands, the secretions of which give the plant a very agreeable balsamic fragrance, — very agreeable indeed when but slightly experienced, but if in too large a quantity, partaking of what is regarded as the disagreeable odour of the common marigold. The flowers are composed of five roundish florets, which have a deep notch at the end. This plant is an incessant flowerer. If sown in the spring with other annuals, and kept in pots till the time of planting out, it blooms from the earlier part of the summer quite up to the time of frosts, when all flowers of a kindred nature are cut off. One quality of it which can hardly be sufficiently admired is, that it never appears littery from the decay of the old flowers. At the end of every small lateral shoot, a blossom is produced; this opens in due time, and continues in beauty its allotted period; and then, ere it fades and becomes unsightly, the fresh lateral shoots rise and spread just above it, producing more flowers; these again are followed in the same way, and so on without intermission; so that the plant always looks as if robed in its holiday suit."

TAIL. The free, projecting, flexible prolongation of the vertebral column in most species of vertebrated animals. It sustains a terminal fin in fishes, a fan or rudder of large feathers in birds, and a brush or mop or whip of long hairs in quadrupeds; and it serves the first for regulating motion through the water, the second for balancing flight through the air, and the third for protecting and defending the body from the attacks of insects and from other nuisances. The tail of a horse usually comprises thirteen bones, and comprises a museum of the most beautiful contrivances for combining gracefulness of appearance with whip-like utility. A fracture of it sometimes occurs from entanglement or violence, and is perceptible generally by the eye and always by the fingers, and must be rectified by either amputation or resetting,—the latter effected by means of a cord with a small weight attached to it passed over a pulley. The tail of a well-bred horse is set on high, and neither seems to be merged between the hips, nor appears to spring saliently from the back-bone, but projects and descends in a graceful curvature. Two cruel usages in the treatment of horses' tails are noticed in the articles Docking and Nicking.

TAIL-SLIP. An imaginary disease in cattle. See the article Palsy.

TALAUMA. A genus of ornamental, evergreen, fragrant, tropical plants, of the magnolia family. Its plants are nearly allied to the true magnolias, but require hothouse treatment. Several species, with respectively white, cream-coloured, and striped flowers, have been introduced to Britain since 1828; and they love a soil of peaty loam, and are propagated from layers.

TALC. A well-known and widely diffused species of mineral. It is rarely seen under a distinctly crystalline form. Its primary form is believed to be a right rhombic prism of 120° and 60°. It is sometimes seen in minute hexagonal

plates, and in a figure resembling the frustra of two cones, applied base to base. Cleavage highly perfect; fracture not observable; lustre pearly upon the faces of crystallization and of cleavage; colour various shades of green, as blackish-green, leek-green, celandine-green, and apple-green; streak similar to the colour; semi-transparent to translucent. It exhibits different colours, sometimes in different directions; sectile in a high degree: thin laminæ are easily flexible. It is one of the softest of all solid minerals. The massive kinds present a great variety of structure. The composition varies from imperfect columnar to granular and impalpable. The individuals are sometimes strongly coherent with each other, or flat, so as to give rise to an imperfect slaty structure. The species talc has been subdivided into a great number of varieties or sub-species, the most of which depend upon colours, composition, and foreign admixtures. The varieties of dark-green (leek-green and celandine-green) colours, inclining to brown, constitute the *chlorite*, which has been subdivided into *common*, *slaty*, and *earthy* chlorite. The first of these contains the granular or crystalline varieties; the second embraces those in which the individuals can scarcely be traced, and which exhibit a slaty texture; the earthy chlorite consists of such as are but loosely coherent, or already in a state of loose, scaly particles. Immediately with those varieties of chlorite whose composition is impalpable, the *green earth* is connected. The species talc comprehends the varieties of pale-green, particularly apple-green, grey, and white varieties, and is divided, in popular language, into *common*, *earthy*, and *indurated* talc. Simple varieties are common talc; also such compound ones in which cleavage is transformed into slaty structure, or such as consist of columnar particles of composition; earthy talc, or *nacrite*, consists of loose particles, or such as are but slightly cohering; and indurated talc refers to imperfect and coarse slaty varieties, in which this kind of structure is more the effect of composition than of imperfect cleavage. If this structure be sufficiently imperfect to become coarse and indistinctly granular, *potstone*, *soapstone*, *lapis ollaris*, or *steatite*, is formed, which, possessing the united properties of softness and tenacity, may be easily turned, and wrought into vessels. Four varieties of the present species, foliated talc, analyzed by Vauquelin, slaty chlorite, analyzed by Gruner, green earth, analyzed also by Vauquelin, and steatite by Klaproth, have yielded

Silex,	62·00	29·50	52·00	59·50
Magnesia,	27·00	21·39	6·00	30·50
Oxide of iron,	3·50	23·39	23·00	2·50
Alumine,	1·50	15·62	7·00	0·00
Water,	6·00	7·37	4·00	5·50
Potash,	0·00	0·00	7 50	0·00
Lime,	0·00	1·50	0·00	0·00

These analyses, as well as those of several other varieties of the species, show that our information respecting its chemical constitution is still very defective. Before the blow-pipe, some of them lose their colour, and are fused with difficulty; others are changed into a black scoria; still others are infusible. Common talc, indurated talc, steatite, potstone, and slaty chlorite, constitute beds of themselves in primitive mountains. The latter often contains imbedded crystals of magnetic iron. Common chlorite is found in beds in rocks consisting chiefly of ores of iron and calcareous spar with augite. Other varieties, and among them the small scaly crystals of chlorite and earthy chlorite, occur in veins of various descriptions, and in the crystal caves of the Alps. Green earth occurs in amygdaloidal rocks, lining vesicular cavities. Tyrol, Salzburg, Switzerland, Sweden, Norway, Scotland, and New England abound in those varieties which by themselves form mountain masses. The soapstone of Cornwall is impalpable in its composition, nearly white, or sometimes mottled with green and purple: when first raised, it is so soft as to allow of being kneaded like dough; but, by exposure, loses a part of its moisture, and is then translucent on the edges, yields to the nail, and possesses an unctuous feel. A similar variety is met with in Wales. It is included in serpentine, and sometimes embraces veins of amianthus. The white varieties of steatite, or those that become so by calcination, are employed in the manufactory of the finest porcelain; other varieties are said to be used in fulling. The Arabs, according to Shaw, use steatite in their baths, instead of soap; and it is confidently asserted that the inhabitants of New Caledonia either eat it alone, or mingle it with their food. Humboldt says, that the Itomaques, a savage race, inhabiting the banks of the Orinoco, are almost entirely supported, during three months of the year, by eating this variety of talc, which they first slightly bake, and then moisten with water. The varieties known under the name of potstone have been in use for the construction of a variety of utensils from time immemorial. It is particularly valuable as a fire-stone in furnaces, and is worked into plates in the fabrication of stoves.

TALINUM. A genus of ornamental exotic plants of the purslane family. Nearly a dozen species, variously annual, biennial, herbaceous perennial, and subshrubby evergreen, mostly about a foot in height, and carrying purple, red, pink, or yellow flowers in the end of summer or early part of autumn, have been introduced to Britain: and about as many more are known. Most love a soil of peaty loam, and require to be propagated from seeds.

TALLOW. The fat of suet freed from all membranous matter by melting and straining. It consists principally of stearin and elain, and yields by distillation a large portion of oleic and margaritic acids. Its ultimate constituents, according to Chevreul, are 78·996 per cent. of carbon, 11·708 of hydrogen, and 0·304 of oxygen.

See the articles Suet, Fat, and Oil. Tallow is used in medicine as an emollient and a demulcent; in pharmacy, to give consistency to plasters and ointments; and in the arts, for dressing leather, for making candles and soap, and for other purposes. Pure tallow is white and tasteless, and differs little from pure lard except in greater density; but the tallow of commerce is very diversified in colour, consistency, sapidity, and odour,—and is commonly classified, according to its degrees of whiteness and purity, into white candle tallow, yellow candle tallow, and soap tallow. A very large quantity is imported into Britain from various parts of the Continent, and particularly from the Russian ports of the Baltic.

TALLOW (Piney). A solid vegetable fat, of somewhat similar appearance and properties to true tallow. It is obtained by boiling the fruit of the *Vateria indica* in water; and is skimmed off in a melted state, and cooled into the form of a solid cake. It has generally a white but sometimes a yellow colour; it is greasy to the touch, with some degree of waxiness; it is almost tasteless, and has an agreeable odour; and it melts at a temperature of 97½° Fahrenheit, and therefore remains solid in the ordinary climates of even some parts of the tropics. It consists, according to Dr. Babington, of 77 per cent. of carbon, 12½ of hydrogen, and 10½ of oxygen. The tree which yields it abounds throughout the western coast of Hindostan, at least as far north as the confines of Canara, and could no doubt afford a sufficient supply to render it of some commercial importance; and it at the same time exudes a resin of the nature of copal, viscous and of a dirty white colour when taken from the tree, but afterwards solid, brittle, and pulverulent, soluble in turpentine, and making as good a varnish as the copal of America. Substances similar to tallow and wax are obtained from several other ligneous plants. See the articles Wax and Stillingia.

TALLOW-TREE. See Tallow (Piney).

TAMARIND,—botanically *Tamarindus*. A small genus of tropical evergreen trees, of the dalbergia division of the leguminous order. The Indian species, *T. indica*, is a native of the East and West Indies, of Arabia, and of Egypt, and was introduced to the botanical collections of Britain in the former part of the 17th century. It is naturally a large, spreading, beautiful tree, of about 60 feet in height. Its leaves are abruptly pinnate, and comprise each sixteen or eighteen pairs of leaflets, and are bright green and downy; its leaflets are sessile, entire, oblong, obtuse, half-an-inch long, and one-sixth of an inch broad; its flowers come out in loose bunches of five or six from the sides of the branches, and have a straw-coloured calyx and yellowish petals, beautifully veined with red, and bloom in June and July; and its pods are thick, compressed, of a dull brown colour, and from two to ten inches long, and contain each from two to seven flat, angular, shining seeds, lodged in a dark-coloured pulp. The prepared pods are medicinal and condimental, and constitute the well-known tamarinds of commerce. They are gathered when fully ripe, freed from all shelly fragments, deposited in layers in a cask, and—in the West Indies at least—saturated with syrup; and they require to be preserved in air-tight and closely-covered vessels. They have an agreeable, acid, sweetish taste; and contain, independently of the sugar with which they are preserved, citric acid, tartaric acid, malic acid, fecula, gum, vegetable jelly, and bitartrate of potash; and owe their acid taste mainly to their citric acid. They possess cooling and gently laxative properties; and, when infused in hot water and strained, they make a very grateful and refreshing beverage for persons in fever.—The western species, *T. occidentalis*, is very similar to the Indian, but not so tall, white-flowered, and much earlier in bloom.—Both species love a soil of rich mould, and are propagated from seeds.

TAMARISK,—botanically *Tamarix*. A genus of calyciflorous plants, principally shrubs, with small, entire, scale-like leaves, and small, white, pink, or flesh-coloured, spicate or racemose flowers, constituting the small natural order Tamariscineæ. The plants occur in all the three great divisions of the old world,—in both cold countries and hot; and they are somewhat nearly allied on the one hand to Onagrariæ, and on the other to Lythrarieæ, but differ from both in some very distinct botanical characters of the flowers. One species grows wild in Britain; two hardy deciduous and three tropical evergreen species have been introduced from other countries; and about a dozen other species are known.

The French tamarisk, *T. gallica*, occurs naturally in some parts of the southern coasts of England, and is also a native of France, Spain, and Italy. It is a deciduous shrub, and commonly attains a height of about 12 or 14 feet. Its branches are few, and spread irregularly abroad, and are variously upright, horizontal, and pendulous; its bark is smooth, and has a purplish or deep red colour toward the sun and a pale brown colour on the opposite side; its leaves are very narrow and very finely scaly, and have a rather pale green colour and a very beautiful appearance; and its flowers have a pale red colour, and grow in seemingly very large panicles, and bloom from May till October,—but they really grow in spikes, and are produced near the extremities of the branches on the slender twigs all around, and not only are they individually very minute, but each of the spikes taken separately is rather small. This plant is highly elegant, and well deserves a place in shrubberies. It thrives in any ordinary soil or situation, and is easily propagated from cuttings planted in the open ground in spring or autumn. Sheep feed greedily upon it for the sake of its salt taste.

The German tamarisk, *T. germanica*, was intro-

duced to Britain from Germany in the latter part of the 16th century. It is a more regular deciduous shrub than the French tamarisk, but has commonly a height of only 8 or 9 feet. Its branches all grow more or less upright, and are odorous and very brittle; its bark is smooth and yellowish; its leaves stand much closer than those of the French tamarisk, and have a scaly appearance, an exceedingly light green colour, and a highly ornamental character; and its flowers come out in long loose spikes at the end of the branches, and are individually small and of a pink colour, and bloom from June till September. The spikes attract the attention and excite the admiration of all observers; and besides having a noble appearance during the period of bloom, they continue to be beautiful till the period of the ripening of the seeds, and then seem to dissolve into shattered down and scales. This species loves a light moist soil, and is propagated in the same manner as the preceding.

TAMETOMO. See Lily.

TAMONIA. A small genus of ornamental, herbaceous, tropical plants, of the verbena family. Two species, both biennial, blue-flowered, blooming in July and August, and about a foot high, have been introduced to the hothouses of Britain from Guiana and the West Indies.

TAMUS. See Bryony (Black).

TAN. Oak-bark which has been chopped and ground into a coarse powder for the use of tanners, and which has been employed in the process of tanning leather, and afterwards thrown out and dried. See the articles Leather and Tannin. Tan is much used in horticulture,—both in a fresh state to produce heat by its fermentation, and in a well-rotted state as manure for all kinds of cold stiff soil. See the articles Bark-Bed, Hotbed, and Manure. Tan is also used, in various ways and after widely different methods of preparation, as both an incorporated manure and a top-dressing in agriculture. Fresh tan, when laid on grass-land in autumn, so as to be retarded in fermentation by frosts and washed into the ground by the winter's rains, greatly improves the grass; but when laid on in spring, especially if a tract of dry weather should follow, it may evolve such strong heat by fermentation as will scorch and burn the grass. Tan ferments sturdily and very prolongedly, and resists putrefaction, and though very absorbent and retentive of moisture, cannot be penetrated by the roots of plants; so that it does exceedingly ill to be employed in a fresh or merely half-fermented state as an incorporated manure. Yet it is very rich in the principles which nourish cultivated field-plants; and may be made thoroughly available for their nutrition either by complete preparatory rotting, or more economically by reduction with solvents; and was reckoned by the old gardeners to be, in a well-rotted state, worth more than twice its weight of rotted farm-yard manure. Stable dung has been used as a solvent, but caustic lime acts more rapidly, more powerfully, and with less waste by gaseous dissipation; and after it has effected a destruction of the fibre, earths and dung may be added to bring the whole mass into a soluble and perfectly putrescent state; and the mixture thus prepared has a finely divided and even comminuted texture, and may be used, either in the field or in the garden, for any purpose of either top-dressing or incorporated manuring.

TANACETUM. See Tansy.

TANGHINIA. See Cerbera.

TANGIER PEA. See Lathyrus.

TANK. An excavational structure, cistern, or reservoir for collecting and preserving in places where it is scarce, or for receiving and accumulating large quantities of any useful liquid.

A water-tank is an essential appendage to a dwelling-house, a farmery, or a garden in every district where a sufficiency of water for routine use can be obtained only by preserving supplies from rain or by accumulating them from meagre or uncertain springs. Some water-tanks are formed for collecting water, as well as for preserving it; some with open surface to receive rain as it falls, and others with only minute apertures to admit a rill and to give off supplies; some with entirely sunk space, of the nature of ponds or subterranean reservoirs, and others with more or less elevated space, of the nature of above-ground cisterns; some with walls of stone or timber in masonry or wood-work, and others with enclosure or frame of metal in the manner of plumbing or cast-iron work; some with ventilating and filtering appliances for adapting the water to the nicest uses of the kitchen or the table, and others with merely the coarse and ordinary appliances of a garden reservoir or a cattle drinking-pond. The constructions of them, therefore, in adaptation to different sites, circumstances, purposes, sizes, and materials, are so endlessly varied, as to be irreducible to any small number of rules or directions, and must be determined in each case by the judgment of the proprietor and his mechanics. We shall only say that a sufficiently good large one for the coarsest uses of the farmery may be constructed on the principles mentioned in the article Pond; and that every prime or even tolerably good one for the finest uses of the dwelling-house ought to comprise appliances both for filtering either by ascension or otherwise, and for sweetening and purifying by constant currents of air.

Tanks for the receiving and accumulating of liquid manure possess great importance in the economy of farming; and as they require to be of large capacity, and must be excavated a little beneath the level of the farmery in whatever kind of ground occurs in its vicinity, they always involve nicety, and sometimes considerable difficulty, in their construction. But Mr. Kinninmonth of Invertiel, in a Prize Essay in a recent number of the Transactions of the Highland So-

ciety, discusses the principles of them so well, that we cannot do better than copy a considerable portion of his paper. "Experience," says he, "led to enquiry as to the best means of constructing large tanks; and here it appeared, in the first place, that failures had occurred in consequence of projectors of tanks having adopted methods that promised great economy in the construction, but which eventually proved failures. In some cases the defects had arisen from the tank being incapable of retaining the liquid collected therein, while, in others, it arose from an opposite cause—the incapacity of preventing the circumjacent water from entering the tank and too much diluting the manure; hence, in place of an economical result, such tanks were rendered useless, unless a double expense was incurred to reconstruct them. It appeared also that some of those failures had been, in some measure, the result of neglecting, on the part of the constructor, the laws of hydrostatics. Thus, in the case of tanks being formed like wells—that is, their depth being considerable—in which case the counteraction necessary to resist the hydrostatic pressure becomes greatly more difficult, whether from the liquid within or from the circumjacent water pressing from without. For this reason alone it became a fixed point, in the views of the writer, that, in all cases, there is safety in avoiding the construction of deep wells to serve as tanks.—Still further consideration of the subject led to the inquiry as to the best form of a tank, and this was found to involve another question—the nature of the ground and substrata in which the tank is to be formed. It is, in the first place, evident, from the case of well-tanks already stated, and from due consideration of the effects of hydrostatic pressure, that the difficulties and even the expense of construction, especially as regards tightness, will always be diminished in proportion to the decrease in depth of the tank; and in no case should the depth exceed eight or nine feet. In most cases it will be advisable to limit this to six or seven feet, or even less, where the ground may be unfavourable. It being essential also that tanks should be closely covered, both for safety and preserving the ammonia, it follows that arching with stone or brick, as being more durable than timber, should in all cases be resorted to; but since arching becomes more expensive as the extent of the span increases, it becomes necessary again, with a view to economy, that the width of the tank be limited to six or eight feet, and from this it follows that *capacity* must be always obtained, principally by extending the length; or, when circumstances require that a tank must be limited in its length, *capacity* may be obtained by extending the width to two or even three times the limit here prescribed, and then subdividing it into three chambers or vaults, by division walls, in which requisite openings are formed to give the effect of one reservoir. Upon these and the boundary walls, two or three arches, as the case may be, are to be thrown, covering in the whole area. This last form of tank, while it may appear more expensive, will, in fact, be rather less so than the single one.

"The actual construction of tanks will always be, in some degree, modified by the strata in which they are placed, and, from the different nature of the strata, may be divided into three kinds, viz., clay, rock, and gravel, but in each of these there will be varieties. Tanks formed on the first kind of strata, especially on the mountain or boulder clay, will be done with little difficulty, such clay being generally highly impervious, and will require only the requisite excavation, and lining the same with walls of rubble masonry to carry the arched covering. In the alluvial clays, in which pervious strata sometimes occur, it may be necessary to treat the construction in the same manner as will be required in the more pervious gravels and rocks, that is, by careful puddling; but there are many localities where this variety of clay is quite impervious, and hence nothing but excavation and building are necessary. In the second kind—rocks—the same variety of circumstances may occur; they may be perfectly dry, or they may contain springs of water. In the first case nothing more is necessary than to excavate and build; but, in the second, every precaution is required, both to prevent entrance of spring water and the escape of the manure. To puddle only, in such a situation, would be endless; for, whenever the tank might be emptied of the manure, the circumjacent water would press upward against the bottom puddle, which, if not pervious, would be broken up, and so admit water, and in either case the destruction of the tank must follow. To secure a tank in such a position, the certain method is to carry a drain from the lowest point of the excavation to the nearest outlet—this being done, all danger of pressure from without is removed, and the tank may be completed with a layer of puddle all over the bottom and sides, upon and against which the rubble walls are built, with the certainty of a successful result. In the class of gravels, artificial drainage will seldom if ever be required, there being seldom any danger of hydrostatic pressure from circumjacent water—the construction of a tank here will therefore proceed, as last described, by puddling and building. But, should it so happen that water is found to stand in the excavation, then draining must be resorted to; for it is incompatible with the nature of such a structure that it can both hold in and hold out water; for, though the sides might stand, the bottom would ultimately be forced upward, unless recourse is had to the expensive alternative of an inverted arch of stone or brick, laid over the bottom puddle. Localities may indeed occur where such an expedient might be advisable, but such a case must be the exception and not the rule. In the construction

of tanks it should be kept steadily in view, that where puddling is required it becomes the essential means of rendering the work perfect; and, therefore, the greatest care should be bestowed upon it. The kind of puddling required for the purpose is what may be named dry puddle. It is well tempered pure clay brought to such a firm consistence as will just allow of any two pieces, on being pressed together, to unite into a solid mass. It is made up into irregular balls or lumps and thrown with force into its place. A succession of such balls are laid all over the bottom of the excavation to the depth of at least one foot, they are thrown down, pressed, and beaten firmly together till the whole forms one solid mass. When the stratum of bottom puddle has been sufficiently consolidated, the side walls are founded upon the puddle with broad flat stones. The bottom puddle must extend to at least one foot in breadth beyond the foundation of the walls, and upon this extension the wall puddle is founded, being first well incorporated with that of the bottom, and afterwards carried up regularly with the stone walls. The walls and arch may be built in rubble masonry as already stated, or of brick-work. Towards each end of the arch a hatchway or manhole should be formed, for the purpose of gaining access to the tank, and for ventilation when required; but these are usually closed with a cover, and a third opening is required for the pump. The floor of a tank, puddled as here described, must be paved with rough flagstones regularly jointed, or with brick laid on edge, to prevent the waste of the puddle. It is necessary also that the floor have a small declivity towards the point where the pump is to stand. There remains to be noticed that, in choosing a site for a tank, it should be so placed that the surface of the liquid in the tank, when full, shall be sufficiently below the level of all the sources of supply, as to give a free current from them through the drains or conduits to the tank. It is advisable also that the conduits should be water-tight, for which purpose burnt-clay pipes, of three to four inches bore, properly jointed, are the most eligible; and, to prevent choking of the conduits, their eyes should be defended by a grating, besides having a water-trap or cess-pool immediately under it, to intercept any grosser substances that might enter, and which in time tend to close up the conduits. It is also worthy of notice that, on some farms, the position of the steading, if on sloping ground, may allow of the tank being so placed as to admit of its contents being drawn off by a pipe and stop-cock, and thus delivered into the manure-cart without the intervention of a pump." See the articles LIQUID MANURE and LIQUID MANURE CART.

TANNER'S-BARK. See TAN, BARK, and TANNIN.

TANNIC ACID. The peculiar vegetable principle which combines with the gelatine of skins and converts them into leather. See the article LEATHER. It can be separated from the vegetable substances which most abundantly contain it, and especially from gall-nuts, by any one of several chemical processes; and, when separated and purified and dried, it is a white, odourless, fiercely astringent, uncrystallizable powder, very soluble in water and alcohol. A solution of it reddens litmus paper; and, when exposed to the air, becomes yellow, yellowish-brown, and dark-brown; and when evaporated to the consistence of an extract, is rendered partially insoluble. It destroys the acidity of acids, or completely swallows it up in its own astringency; and is decomposed by nitric acid and by chlorine in a very obscure or complicated manner; and is precipitated by the carbonates of potash and ammonia, by alumina, by the alkaline earths, and by many of the oxides of the common metals. It forms with the peroxide of iron, or still better with a mixture of the peroxide and the protoxide, a black-coloured compound which, together with gallate of iron, constitutes the basis of writing ink and of the black dyes; and it combines with gelatine in solution to form a yellowish flocculent precipitate which is insoluble in water, and powerfully resists putrefaction, and becomes hard and tough when dry. This precipitate bears the name of tannogelatine, and is the essential basis of leather, and is always formed and deposited within the substance of skins when they are macerated in an infusion of bark. The ultimate composition of tannic acid, according to Berzelius, is 52·69 per cent. of carbon, 43·45 of oxygen, and 3·86 of hydrogen.

TANNIN. Impure tannic acid. Yet the names tannin and tannic acid are very often used as strictly synonymous, by the former being put instead of the latter. Tannin occurs in the bark of most trees, in the excrescences or gall-nuts of several species of oak, in some inspissated juices, such as kino and catechu, in the leaves of such plants as tea, sumach, and whortleberry, and in general in all astringent parts of all astringent plants. It is in fact the chief principle of vegetable astringency; but it varies somewhat in character in different plants, somewhat in quantity at different seasons in the same plant, and very greatly in proportion or relative amount in the corresponding parts of different plants. For example, the tannin of some plants strikes a green colour with salts of iron, while that of most strikes a black or a bluish-black colour; the tannin of any tree is generally more abundant in the inner cortical layers of the bark than in other parts, and much larger in quantity at the budding period of spring than in any period of autumn and especially of winter; and the percentage of tannin in a few of the principal substances which contain it is as follows,—2·2 in willow bark, 2·7 in elm bark, 4 in the inner coloured bark of the oak, 4·3 in chestnut bark, 6·3 in ordinary oak bark, 8·5 in green tea, 10 in

souchong tea, 10·4 in Malaga sumach, 15 in the inner white bark of old oak, 15·2 in the inner white bark of Indian chestnut, 16 in the inner white bark of young oak, 16·2 in Sicilian sumach, 27·4 in nut-galls, 48·1 in Bengal catechu, and 54·3 in Bombay catechu. It is naturally accompanied with gallic acid in tea, gall-nuts, and most kinds of bark; but is not so accompanied in kino, catechu, and cinchona bark.

Artificial tannin can readily be made by digesting charcoal in diluted nitric acid, in the proportion of 100 grains of charcoal, one ounce of nitric acid of density 1·4, and two ounces of water, by exposing the mixture to a gentle heat till all the charcoal is dissolved, and by evaporating the solution to dryness, using care toward the close of the process so to regulate the heat as not to effect decomposition. It may be made also by the action of nitric acid on animal charcoal, on pit-coal, on asphaltum, on indigo, or on various resinous substances; and by the action first of sulphuric acid and next of alcohol on camphor, common resin, balsams, asafœtida, and similar substances. It is brown, astringent, fusible, of resinous fracture, and soluble in cold water and in alcohol, and acts precisely in the same way on a salt of iron and on gelatine as natural tannin does, but is not decomposed by the action of strong nitric acid.

TANNING. See Leather.

TANNO-GELATINE. See Tannic Acid.

TANSY,—botanically *Tanacetum*. A genus of herbs and shrubs, of the chamomile division of the composite order. One species grows wild in Britain, and is cultivated in kitchen gardens; upwards of a dozen species—four of them greenhouse evergreen shrubs, and most of the others hardy, perennial-rooted, annual-stemmed herbs—have been introduced from other countries, but possess little interest; and a number of other species are known. Most of the introduced species, as well as the indigenous one, are yellow-flowered and have a height of about two feet.

The common tansy, *Tanacetum vulgare*, grows wild on road sides and similar situations in various parts of Britain. Its roots are perennial; its stems are annual, solid, smooth, unbranched, and about two feet high; its leaves are doubly pinnatifid, deeply serrated, and of a dark green colour; and its flowers grow in dense terminal corymbs, and are numerous, and have a golden yellow colour, and bloom in July and August. The whole plant emits a strong but not unpleasant odour, and has a bitter taste, and is alleged to possess tonic, cordial, and anthelmintic properties, and has long figured in horticultural catalogues as an aromatic herb for making tansy pudding and for other kitchen uses; but it does not agree with every stomach, and has quite lost a large portion of its culinary reputation. Two varieties of it occur in gardens,—the double or curled and the variegated or striped-leaved; and the former is cultivated for culinary purposes on account of being milder and more grateful than the wild sort, while the latter possesses some little claim to a place in the flower-garden. Tansy is propagated from slips or offsets of the root, planted in spring or autumn, at distances of 12 or 18 inches.

TAPEWORM. See Worms (Intestinal).

TAPIOCA. See Cassava.

TAP-ROOT. A root which penetrates perpendicularly and deeply into the ground, without dividing into branches, or sending off many lateral fibres. A simple tap-root is generally spindle-shaped, and therefore is designated fusiform; and, in many instances, as in those of the carrot and the parsnip, it is fleshy and juicy, and is therefore termed succulent. But the tap-root of a tree or of any other plant which takes wide and complex anchorage within the ground, is merely the main-trunk of a root descending perpendicularly, just as the top or leading shoot of the stem ascends vertically.

TAR. A viscid, dark-brown, resinous semi-fluid, obtained from the wood of the Scotch pine, the long-leaved pine, and other resiniferous trees of the pine and fir tribe. A conical cavity is dug in the ground, commonly in the side of a bank, or on the slope of a hill, within or near a forest; billets of the roots and branches of pine are filled into the cavity and piled above it till they form a large stack; a covering of turf is placed over the whole, and beat firmly down; the stack is kindled, and allowed to burn with a slow smothered combustion; the tar is formed, during the burning, by the decomposition of the resinous juice of the wood; a cast-iron pan at the bottom of the cavity receives the tar as it descends, and delivers it by a projecting spout through the bank or other base of the cavity into barrels placed to receive it; and the barrels, immediately on being filled, are closed with bungs, and are then ready for exportation. Most of the tar used in Britain is brought from Russia, Sweden, and Denmark; but a considerable quantity also is brought from the United States.

Tar is a very compound substance, and contains modified resin, oil of turpentine, empyreumatic oil, acetic acid, charcoal, and water; and when inspissated by boiling, it is converted into pitch. It is extensively used in the cordage, caulking, and sheathing of ships to preserve them from decay; and is of great service in many of the arts and medicinal usages connected with agriculture. It serves well as a paint to coarse kinds of boarding and paling, but is improved, in this use, by being mixed with tallow or other coarse fat. It is highly useful in various details of sheep management, as in some kinds of topical shelter, and as an application to cuts from clipping and to parts affected by the fly. It serves, either alone or in combination with some fatty substance, to defend the sore or diseased feet of cattle from being further injured by wet or abrasion; and, when spread upon coarse cloth, it is a

prime covering for broken horns, and makes an excellent application to various kinds of wounds and punctures in cattle. Tar in substance is sometimes administered internally to horses as a remedy for cough. A mixture of equal parts of tar and some solid fatty substance is the common stopping used by farriers for diseased feet; a mixture of equal parts of tar and oil is an excellent and extensively-used dressing for hoofs; and a liniment composed of two parts of tar, two of cocoa-nut oil, and one of yellow wax, is a good dressing for mange and an efficient detergent in most kinds of scabby, eruptive, cutaneous affections in the horse, but requires to be rubbed in with a piece of hair-cloth or with a rather stiff brush. The rectified oil of tar, popularly called the spirit of tar, is sometimes used alone for mange, though not always with effect; and a mixture of it with twice its bulk of fish oil, when well-rubbed with a brush every night on both crust and sole, is an eminently good application for hardness and brittleness in the horse's feet.

TARAXACUM. See DANDELION.

TARCHONANTHUS. A genus of ornamental exotic plants, of the chamomile division of the composite order. The camphor-scented species, or African fleabane, *T. camphoratus*, is a native of the Cape of Good Hope, and was introduced to British gardens near the end of the 17th century. It is an evergreen shrub of from 10 to 14 feet in height, and sends out many leafy branches at the top, and may be trained up to a regular head. Its leaves are shaped like those of the broad-leaved sallow, and have a downy surface like those of sage, and emit an odour like those of rosemary when bruised; and its flowers are produced in spikes at the extremity of the shoots, and have a dull purple colour and an inconspicuous appearance, and bloom from June till October. This plant helps to adorn the greenhouse or the conservatory in winter; and it loves a soil of peaty loam, and is propagated from cuttings. Another and smaller species has been introduced; and several more are known.

TARE. The common cultivated vetch,—*Vicia sativa*. See the article VETCH.

TARE,—botanically *Ervum*. A genus of annual-rooted, herbaceous, climbing plants, of the vetch division of the leguminous order. Two species grow wild as weeds in the corn-fields, hedges, and thickets of Britain; eight species, all hardy, most about a foot high, and two of them subjects of field and garden cultivation, have been introduced from other countries; and eight more are known.

The smooth or four-seeded tare, *Ervum tetraspermum*, is a troublesome British weed, particularly on rather moist, arable soils. Its root is small and tapering; its stem is weak, quadrangular, leafy, and branched all the way up, and climbs to the height of from 1½ to 3 feet; its herbage, particularly that of the flower-stalks and the calyx is beset with fine soft hairs; its flowers are small, drooping, and of a pale grey colour, and are streaked on the standard and tipped on the keel with a deep blue, and generally come out in pairs, and bloom in June; and its pods are pendulous, oblong, bluntish, and smooth, and commonly contain each four seeds.

The hairy tare, *Ervum hirsutum*, is also a weed of the arable soils of Britain. It somewhat closely resembles the preceding in habit and general appearance, but in general is some inches taller. Its flowers grow in clusters of five or seven, and are very small, and have a very pale blue or almost white colour, with two dark spots on the keel, and bloom in June and July; and its pods are short, and beset with hairs, and of a dark brown colour, and contain each two large prominent seeds.

The lentil tare, or common lentil, *Ervum lens*, is noticed in the article LENTIL. It is generally called dill in those parts of England where it has been tried as a field plant; and though highly esteemed in quality—as green food for suckling ewes, as haulm-fodder for all kinds of cattle, and as ground seed in mixture with barley or potatoes for fattening pigs—it has been found so comparatively poor in quantity that, except on land which does not suit vetches, it has ceased to be cultivated by even such English farmers as have most strongly liked it. Every plant, on the average, has a close branching habit of growth, and produces from 100 to 150 pods, or even a greater number.—The small variety of it is the kind most commonly grown for green food in France. It is rather taller and later than any of the other three varieties; its flowers are reddish; its pods are often two-seeded; and its seeds have each a diameter of little more than one-eighth of an inch.—The large variety is the most productive, but is regarded on the Continent as inferior to the yellow in quality. Its height is from 12 to 15 inches; its flowers are very small and whitish, and stand commonly two but sometimes three on a footstalk; its pods are flattened, about three-fourths of an inch long and one-half broad, and generally one-seeded; and its seeds are round, compressed, of a whitish or cream colour, and each about three-eighths of an inch broad and one-eighth thick.—The yellow or common variety is the kind most esteemed in Paris. It is about as early as the large, and differs from it principally in the smaller size and better quality of its seeds.—The red variety is about as early as the large and the yellow. Its flowers have a light red colour; and its seeds are reddish-brown, and of smaller size than those of the large.

The one-flowered tare, or one-flowered lentil, or jointed vetch, *Ervum monanthos*, was introduced to Britain about 50 years ago from the South of Europe. Its stems are 12 or 15 inches high; its flowers are purple-coloured and bloom in June and July; its pods are subinflated, oblong, linear, and generally three or four-seeded; and its seeds are globular, of a dunnish-brown

colour, often slightly wrinkled, and from one-eighth to two-eighths of an inch in diameter. This plant is much less esteemed than any of the varieties of the common lentil, yet is cultivated, for the sake of both its herbage and its seeds, in some parts of France and of other Continental countries.

The tare-lentil or vetch-tare, *Ervum ervilia*, was introduced to Britain from the South of Europe toward the close of the 16th century. It closely resembles the preceding in height, habit, flower, and pod, and is also cultivated.—The slender and the pubescent tares, *E. gracile* and *E. pubescens*, the former pale blue flowered, the latter purple flowered, and both similar to the two preceding in height, habit, and pod, were introduced within the last 30 years from the South of Europe.

The small lentil tare, *Ervum lenticula*, was introduced in 1820 from Carinthia. It has a general resemblance, especially in pod, to the common lentil; but is regarded by some botanists as a chick-pea. Its flowers are blue.—The blackish tare, *E. nigricans*, was introduced from Tauria in 1817. It still more closely resembles the common lentil; but has purple-coloured flowers. —The two-seeded tare, *E. dispermum*, was introduced from India in 1802. It is somewhat lentil-like, and has a height of about 20 inches, and carries purple-coloured flowers.

TARTAR. See Teeth.

TARTAR (Cream of). See Cream of Tartar.

TARTAR EMETIC. See Antimony.

TARTARIC ACID. This acid, as it exists in vegetables, is usually combined with potash, forming a salt with an excess of acid—the super-tartrate or bi-tartrate of potash. This salt is deposited in considerable quantity from the juice of the grape during its conversion into wine, or rather from the wine during the slow fermentation which it suffers in the cask. It does not appear to be a product of the fermentative process, but exists before this in the juice of the grape, and is merely separated. It also exists in other fruits, particularly in the tamarind, of which it forms a considerable part. As deposited from wine, it is impure, having mingled with it colouring matter and tartrate of lime. In this state, it forms the crude tartar of commerce, named *white* or *red tartar*, according to its colour. It is purified by boiling it in water, with the addition of a small quantity of fine clay, which attracts the colouring matter. By evaporation, it is obtained crystallized, forming the purified tartar, crystals, or cream of tartar of the shops. From this salt the tartaric acid is obtained, by adding to a solution of the super-tartrate of potash in boiling water, carbonate of lime in powder, as long as any effervescence is excited: the tartrate of lime which is formed and precipitated, being well washed, is decomposed by adding sulphuric acid equal in weight to the chalk that had been employed, previously diluted with half its weight of water, digesting them with a moderate heat: the sulphuric acid combines with the lime and forms the sulphate, which, being of sparing solubility, is separated, while the tartaric acid is dissolved by the water, and, by evaporation, is obtained in a crystallized form. The crystals are tables or prisms, white, and nearly transparent. Their taste is sour, and they deeply redden vegetable blues. They are very soluble in water, and form a solution so concentrated as to have an oily appearance. By the action of very strong nitric acid, tartaric acid is converted into oxalic acid. The crystals are composed of acid 66 and water 9 in 75 parts. The acid appears to be composed of

Hydrogen,	4·48
Carbon,	35·82
Oxygen,	59·70
	100·00

Tartaric acid is decomposed by heat, affording, among other products, a white sublimate, which is a peculiar acid, named, from its origin, *pyro-tartaric acid*, which has been regarded by some as acetic acid disguised by the addition of a little oily matter. Tartaric acid combines with the alkalies and earths, forming salts named *tartrates*. The acid appears to have a peculiar tendency to enter into combination with more than one base, and to form ternary salts. It has also a tendency to form salts with an excess of acid, in uniting with those bases, with which it forms soluble compounds. Tartrate of potash is usually formed by neutralizing the excess of acid in the bi-tartrate, by the addition of carbonate of potash. From its affinity to water, it is not easily crystallized, but, by a slow evaporation, affords four-sided prisms. It is deliquescent in a humid atmosphere, and very soluble in water, whence its name, also, of *soluble tartar*. Tartrate of soda is soluble and crystallizable. A triple salt, the tartrate of potash and soda, or *Rochelle salt*, is formed by neutralizing the excess of acid in the super-tartrate of potash, by adding carbonate of soda. See the article Rochelle Salt. Tartaric acid acts on some of the metals, and it may be combined with the oxides of all of them by double affinity. By employing the bi-tartrate of potash to act on these oxides, ternary compounds are obtained. The most important of these is that formed with the oxide of antimony,—long known in medical practice under the name of *tartar emetic*, as one of the mildest and most manageable of the antimonial preparations. See the article Antimony.

TARTONRAIRA. See Daphne.

TARUGA. See Alpaca.

TAUSCHERIA. A small genus of hardy, ornamental, exotic, annual plants, of the cruciferous order. Two species, the naked-podded and the hairy-podded, both about 6 inches high, white-flowered, and blooming in June and July, were

introduced to Britain within the last 30 years from Siberia.

TAXES denote that portion of their property which the government of a state exacts, for the supply of the public necessities, from its subjects, or other persons residing in the country and partaking of its advantages. Hence they form a part of the state-revenues. Another part is formed by the revenues from the domains, and from the royal prerogatives, so far as the last afford only official gains, and are not used at the same time as means to exact or to raise taxes.

In most states, particularly in those of ancient times, the public expenditures were supplied from the revenues of domains and royalties, which were considered, the former as the property, the latter as privileges, of the sovereigns. As the expenses of the state continually increased, or the rulers, from bad economy, found the above-mentioned sources of revenue insufficient, they began to demand contributions from the members of the community, and imposed upon them taxes or imposts. They usually, however, met with great difficulties, since the nobles would not suffer themselves to be taxed, under pretext of forming a state within themselves, and maintained that such contributions could be raised only with their consent. What could be obtained from them voluntarily, was very little. They, however, acknowledged the necessity of increasing the revenue of the state; but the sovereigns were afraid to constrain them to contribute, and inclined to grant them exemption from taxes, if they would only consent that the rest of the nation, which did not belong to their privileged order, should be subjected to imposts. The nobles, fearing that if no other source of revenue were left open to the sovereign, the burden of taxes would finally fall on themselves, willingly allowed him the right of taxing the rest of the nation, which, from want of union and power, was obliged to yield. Thus the taxes, for a long time, were laid almost everywhere on the commons only, the higher and more powerful orders, the clergy and nobility, being exempt. Enlightened governments, however, early perceived that, in order to render taxes a permanent source of revenue, means must be left to the subjects, of gaining, every year, so much as to be able to subsist, and to have a sufficient sum remaining to pay the taxes. Hence they were induced to refrain from exhausting their property. But a long time elapsed before the principles of equitable taxation were well understood. It was not till a late period, since government has become an object of profound reflection and a more perfect system of political economy has arisen, that a theory of taxation has been formed, which can be used as a solid basis of revenue. According to this theory, taxes are the portions of the property of individuals, which each has to contribute to the public treasury, to defray the public expenses. From this definition it follows,—

1. That no one should be exempted from taxes, who possesses property or income, and is protected in his person and estate, and that, in consequence, absolute freedom from taxes in any individual, so situated, is unjust towards those members of the community who are charged with them.

2. That the taxes ought to be assessed according to the net income of each individual.

3. That the taxes must never be suffered to injure the sources of income.

4. That the ratio of taxes to income ought to be as small as possible, in order that the revenue of the nation, as well as of the individual, may be allowed to increase.

The greatest difficulty in effecting a just distribution of taxes, is to find the clear income of every individual. In the mode of taxation formerly practised, this difficulty was but little considered. Financiers were satisfied with laying taxes where they observed property or income, without caring much whether they were taken from the gross or net income, from the capital, or from the interest and profits. The rudest mode was to assess the taxes according to the number of heads. On the supposition that every one receives enough to pay something, they demanded from every head such a sum as, it was presumed, even the poorest could afford: the rich and the poor paid the same amount; and, therefore, the greatest inequality prevailed. Real property was early taken as a standard in distributing the taxes, as cultivated land, in civilized countries, appeared to be the safest and most substantial property. As this afforded to its proprietors or cultivators a certain income, the annual produce of the lands of those who were declared subject to taxation was estimated, and, after this ratio, the tax was distributed on real property. Thus arose the land tax, in which, however, the gross and net produce of the lands were seldom accurately distinguished; and where it was done, little dependence was to be put upon the estimate itself, and still less on the maintenance of this principle through the changes of income.

As the land tax was insufficient to furnish the necessary revenue, other means were sought for, and the closest attention was paid, particularly as the circulation of money increased in civil society, to all those quarters where money appeared. Wherever money changed hands, as in sales, exchanges, inheritances, taxes were laid. Whoever desired to obtain any favour from the public officers, was obliged to purchase it with money. When property was acquired, something must be relinquished. Hence the long series of taxes on acquisition and industry. As the income of the members of the community did not yield so much as the state required, the attention of governments was directed to expenditures; and people were made to pay, wherever their expenses could be estimated. Thus taxes on

consumption of every description were established. When taxes began to be treated scientifically, which was not till a long time after the different kinds had been invented and introduced, attempts were made to bring the whole mass of the existing taxes under a general system.

All taxes may be arranged under the following classes: taxes on the *possession*, on the *acquisition*, or on the *enjoyment of property*. In order to judge whether they are rightly distributed, it must first be considered, whether they can be paid regularly and continually from the net income or not. There may be a possession which brings no gain at all, as a library, a collection of pictures, &c. If an annual tax is laid upon such property, it would, sooner or later, consume the property if it were to be paid from it, and, consequently, would contradict the principles above laid down, that property should be taxed only so far as it affords a regular income. In like way, acquisitions can be taxed, according to the principles of political economy, only when they are a permanent source of gain. If, therefore, any one acquires an estate or a capital by purchase, exchange, &c., and taxes are laid upon such an acquisition, the tax is taken from the capital, that is, from the means destined to produce profit. As far as this happens or is in danger of happening, the system of taxation is defective. If, in fine, a tax is laid on enjoyment, or the value of things enjoyed, this can be justified only so far as he who purchases or enjoys such things can afford the expense, from an income which furnishes more than enough for his subsistence, and the source of which is not necessarily diminished by the tax. If we seek, therefore, for the principle of the distribution of taxes, which ought to serve at the same time as a rule for judging of the propriety of the distribution, this can be no other than the *net income* of the persons, or the *net produce* of the property.

Net income or net profit is that part of income or profit which remains after the portion necessary for the maintenance of the person, or the continuance of the property which produced the income or the profit, has been subtracted. An income and profit are produced either, 1. from land; 2. from capital; 3. from labour. All taxes will be just and useful only so far as they are a part of the net produce from these sources, and are imposed and distributed after this principle. But as it is difficult, and in many cases impossible, in practice, to ascertain the net revenue of every one, the politician must take different ways to find the just proportion. The first way is direct—to determine, from the statement of the parties concerned, or from official estimation, the net income of the persons, or the net produce of the land, and to assess the taxes according to the result. This kind of taxes is called *direct*. But as this mode leaves a large portion of net incomes doubtful, their amount is sought for in an indirect way. It is supposed that he who receives more than the amount at which he has rated his income, will consume and enjoy more than this sum will warrant, and, in particular, that he will enjoy certain articles which the man of smaller income consumes not at all, or not in equal quantity. If, now, the expense for articles of consumption is taxed, an additional sum can be generally drawn from all those who pay already a direct tax on income, not sufficient, however, to cover the expenses of the state. This sum they can pay from their net income, if their affairs are properly arranged. In this way, something more is obtained from the net income of those who have concealed a part, than they would have contributed if they had been taxed merely according to their own statement. These taxes are termed *indirect*, as they are calculated like the others on the net income, but only in an indirect way. The art of reaching this net income by taxes on consumption, or other indirect taxes, still remains very imperfect. Its perfection is, however, necessary, if the system of taxation is to be established according to just principles.

Another signification is usually attached to the division of taxes into direct and indirect. The mode in which they are raised is made the principle of denomination. By direct taxes are understood such as are laid immediately on the consumers; by indirect taxes, such as are assessed on others in advance, who are left to remunerate themselves from the rest of the community. But this principle does not afford a logically correct division; for the same tax can be raised at one time directly, at another indirectly. Thus all taxes of consumption may be raised as well from those who consume the articles, as from the tradesmen who deal in them. In like manner, many articles of luxury are taxed directly. Nevertheless, the taxes remain indirect, because the net income only is taxed according to the extravagance of individuals. Taxes imposed on goods at the time of their importation, are denominated *customs*, *duties*, or *imposts*. Adam Smith mentions one objection to this mode of raising revenue, as the importing merchant must enhance the price of his goods, not only by the amount of the duty advanced by him, but also for interest, profit, and guarantee of that amount, so that the consumer must, in fact, pay more than the tax. This objection is avoided by an excise tax, which is levied on the goods in the hands of the person who uses them, or at the time of their coming into his hands. An annual excise is sometimes levied upon articles of a durable nature, such as carriages, watches, &c.; and the principle on which this is apportioned, is to graduate it according to the supposed expenditure of the persons paying the tax, assuming that this will, as a general rule, be in some near proportion to their income. In respect to imported articles, the excise is either a substitute

for customs, or an addition to them. Considered as a substitute, the excise avoids the objection pointed out by Adam Smith; but then it is an expensive tax to collect, and it necessarily gives rise to an irksome inquiry into the private concerns and habits of people, so that, as far as imported goods are the subject of taxation, the customs are the most convenient, and, on the whole, the most productive tax; and this mode of taxing is almost universally adopted.

It cannot be made a question, among a free people, to whom the right of taxation belongs. In England the principle has long been acknowledged, that taxes are a voluntary donation from the people to the government. On the European continent, where, in the course of time, nearly all national representation has been lost, the physical power of the government is the sufficient argument, as in so many other instances, by which all discussion on the right of taxation is made useless. The theory of taxes has been but very lately illustrated and perfected. Adam Smith laid the first foundation of a complete theory. Before him prevailed the physiocratical system, which, however, has no solid foundations.

Exemption from Taxes.—The privilege of exemption from taxes is granted to some orders of society, to individuals, or to particular kinds of property. The reasons for which it is usually allowed are, 1. the identity of the person exempted with the state; 2. to reward services rendered to the state; 3. as a means of paying debts due from the state; 4. the incompatibility of the public burdens with the office or character of the individual exempted; 5. because an equivalent is received in some other way; 6. poverty; 7. ancient privileges. As to the first reason, it is applicable only to the person of the sovereign; for it would be absurd to load the sovereign with taxes, whilst the taxes are only established in order to afford the sovereign the means of promoting the public welfare. It follows, then, that the revenues of the state must be free from taxes, or that the state itself, considered as a person, must be free from every tax. But whether the individual, likewise, who is invested with the sovereignty, should be entirely exempt from taxes, is a very different question; for, in the revenue of such an individual, there are always two things to be distinguished, namely, *a.* that which is employed by him in the exercise of his public functions, and, *b.* that which serves to defray his private expenses; for it cannot be contended that all which the sovereign expends is devoted to the accomplishment of public objects. In addition to his public capacity, he stands in the condition of a private person, who has his individual wishes and wants to gratify. Now, if the revenue of the ruler is so large as not only to supply that expenditure which is required for maintaining the dignity of the reigning family, but also to suffice for the private gratification of the ruler, the latter part is undoubtedly to be considered like the net income of a private person. In this point of view, there is no sufficient reason why the income of the prince should be free from taxes. It appears rather, for several reasons, advisable to subject it to taxation, like other private property; 1. because in this way the prince feels, proportionally, the burden of the tax in his private capacity, being obliged, like every other man, to restrict his personal expenditure; 2. because the participation of the prince in the public burdens, affords an encouraging example to his subjects, and serves to check the claim of exemption in any other class of society. In those states where the sovereignty is vested in a numerous body, the distinction between that which belongs to the members of the sovereign body, in their public and in their private capacity, is yet more evident. The members of a council who share in the sovereignty, or of the sovereign senate itself, can be as little entitled to exemption from taxes as the members of a sovereign assembly of the nation in a democracy; and the right of a prince to freedom from taxes on that portion of his income which is devoted to his private gratification, is no better founded. If the state would reward an individual for public services by exempting him from taxes, this can reasonably be done only by a personal exemption for his lifetime. To declare his estates free from taxes, is to make him a donation of a sum equal to the tax from which his estates are exempted. But to make this exemption perpetual, would be to make a grant of an indefinite value, and must be regarded as an instance of blind extravagance. In general, this species of reward is one of the most objectionable; for the reward of public services should be drawn from the public revenue, to which all classes contribute in equal proportion. But the remission of a certain kind of taxes usually imposes new burdens on some particular class of subjects. Another objection to this kind of reward is, that it makes exemption from taxes appear an honour, when it is for the interest of the state that a citizen should consider himself the more important the more he contributes to the support of the public burdens. Nearly the same reasons, in particular the last, may be urged against the use of this exemption as a means of paying the salaries of public officers. The privilege too often operates unequally in the case of different officers, one deriving from it a much greater advantage than another. Taxes paid in money are incompatible with no rank in society and no kind of occupation. Other public burdens, personal service, maintenance of soldiers, &c., may, indeed, be inconsistent with one or the other. On that account, it would be better that such burdens should be borne by individuals who are paid at a fixed rate for undertaking them. That the poor pay no taxes, is the natural consequence of a good system of taxation, which charges only the net income. It follows from what has been

said, that a personal right to exemption from taxes cannot be properly granted, and should be abolished where it exists; sufficient indemnification being provided for those who suffer by the measure. These exemptions had their origin in a time of limited views.

As to the exemption from taxes of particular kinds of property, the most remarkable is that which is granted to certain landed estates. This privilege is usually justified by the following reasons: 1. that one estate has undertaken to pay the tax of another. In this way the nobility have often endeavoured to defend the exemption of their estates, by pretending that their ancestors had ceded part of their lands to the peasants, on condition that the latter, in addition to some labour on the lord's estate, should pay the taxes of the same, from the produce of their farms. Such a contract might have been legally made, and might stand good if it had been concluded for a fixed proportion of taxes, and the agreement could be clearly proved; but no compact can be acknowledged as binding, by which one side undertakes to relieve the other from the burden of all future taxes, since no one can know what their amount may become, and whether the land granted would be a proper equivalent; for, in every contract, the nature of the obligation should be definite. But in addition to the fact that such contracts are mere fictions, the state should allow them no validity, because they give to taxes the appearance of an ignominious burden—an idea which no government should favour. 2. Governments have sometimes allowed individuals, and even whole nations, to redeem themselves from a certain tax, for a gross sum; as, for instance, in England, in the case of the land tax. Such contracts must be kept; but no individual, still less a whole class or nation, can purchase an entire exemption from taxes, because the amount of future taxes cannot be estimated, and, consequently, their value cannot be settled. This would be to sell the very means of the state's existence. To sell an improper tax in order to establish a better, as was done with the land tax in England, may be advisable, and certain objects may thus for a time be exempted from taxes; but this is no reason for releasing the income which they afford, for all future times, from taxes. 3. Finally, the privilege of exemption never can be considered as absolutely irrevocable, but is subject to be judged on the general principle of utility, like all other positive laws and institutions; and if found inapplicable, injurious, and oppressive to other classes of citizens, such laws must be amended or abolished. And as the state ought never to persist in old errors at the expense of its citizens, so, on the other hand, those who are to lose the privilege of exemption from taxes, should be indemnified for it according to equitable principles.

TAXODIUM. See Schubertia.

TAXUS. See Yew-Tree.

TAZETTA. See Narcissus.

TEA,—botanically *Thea*. A genus of economical, evergreen shrubs, of the camellia order. The plants of it furnish most of the well-known tea of commerce; but are the subjects of great uncertainty as to their specific characters and arrangement. Two kinds, the black and the green, *Thea bohea* and *Thea viridis*, both white-flowered and commonly from 4 to 6 feet high, the former blooming from August till December, and the latter from February till November, were introduced from China to the greenhouses and conservatories of Britain in 1768; and they are regarded by some botanists as two distinct species, by others as only varieties of one species, and by many persons as mere specimens of a considerable number of different forms into which one wild plant has been wrought by very long and assiduous cultivation. The Chinese themselves, even including most or all of them who take part in tea cultivation, probably could not come to any harmony of opinion respecting the specific characters of the varieties; for they call the wild kind which grows on the mountains of Ho-nan *tchow-tcha* or bastard tea, and designate any variety which yields the largest and best produce for the market the true tea; and were they to study botany and plant-culture after the European style, they would very likely pronounce their cultivated tea-plants to stand related to their wild tea-plant in nearly the same way as our orchard apple-trees do to our wild crab, or as our cultivated cabbages and coleworts and borecoles and cauliflowers do to our wild cabbage. In their practice of preparing different kinds and qualities of tea for the market, too, they are dependent far less on different varieties of plant, than on different stages of growth, different seasons of the year, and different methods of drying and flavouring; and they manufacture black tea and green tea, not from the leaves of two species or two varieties corresponding to the *Thea bohea* and the *Thea viridis* of our greenhouses, but from different growths or kinds of the leaves of one plant, or by different methods of drying even the same growth of leaves.

The stem of the tea-plant is somewhat rigid, of an ashy colour in the lower parts, and more reddish toward the top; the branches are alternate, yet shoot out irregularly; the leaves are elliptic, indented at the top, entire near the base, smooth, firm, glossy, shining, and of a bright green colour; the buds are enclosed in a husk, which drops off; the flowers come out singly from the axils of the leaves, and have a small calyx, generally six white round petals, and upwards of two hundred stamens; the capsules have three round cells, opening longitudinally on only one side; and the seeds are single, globose, and about the size of filberts, and have an oily and disagreeably bitter kernel. The leaves in their fresh or unprepared state are said to possess an intoxicating property; but they lose it on being exposed to

the fire and kept during a twelvemonth. All the varieties of the tea of commerce are prepared for the market by more or less application of artificial heat; and some are highly or repeatedly torrefied. The bohea derives its name from Vo-vyee, the country in which it grows; congo or cong-foo, signifying "great trouble," from the operose method in which its leaves are gathered; pekoe or pe-how, signifying "white leaf," from its consisting only of the leaves of the tenderest of the trees of three years' growth, gathered just after they have bloomed; and souchong or seou-chong, signifying "small good thing," from its being the scarce produce of trees of three years' growth on particular kinds of soil. The leaves which are gathered earliest in the spring afford the strongest and most valuable varieties; those which are gathered late in the year afford the inferior varieties; and those of any season can be made into the green or hyson varieties by peculiar and abundant torrefaction. All the leaves naturally possess an unctuous quality; and they lose almost all of it in the process of drying.

Many adulterations of tea, by admixture of the leaves of old stock, of exhausted specimens, or of totally different plants, are practised both in China and in Britain. The Chinese mix the waste unmarketable teas of former years with the new crop, in order to increase its bulk, and mix other substances with many or most or all of the varieties in order to increase their weight, to modify their colour, or to give them a peculiar flavour; and if they were not checked and controlled by searching inspection at Canton, they would practise such vast and multifarious deception as would speedily throw the whole tea-trade into a state of chaos. They systematically use the leaves of the *Olea fragrans*, in particular, for imparting a special scent to some varieties, and those of the *Camellia sasanqua*, for modifying the appearance and the quality of both good and bad varieties, and those of *Azalea indica*, for producing the small silvery-looking intermixture which characterises pekoe. Among the tricks of adulteration played at home are the intermixing of the scalded and dried leaves of the white-thorn and the common ash, and of the re-dried waste tea-leaves of hotels and taverns.

The tea-plant is indigenous in eastern parts of China and in Japan, and is held in the highest esteem by the natives, both as an article of diet and as a means of national wealth. It has been used by the Chinese from time immemorial, some say from the time of Confucius, as both an invigorating beverage and a medicinal condiment, peculiarly salutary to the human constitution. It has for ages been the theme of their poets, the idol of their husbandmen, and the highest favourite of their emperor and his government; and it is discussed at great length, and with reference to all its history and treatment, in a series of twenty-four native treatises which began to be composed about the seventh century. The consumption of it throughout the vast Chinese empire is so great that, in the opinion of Sir George Staunton, it would not be materially lowered in price to the native consumer if the whole trade in it to Europe were abandoned. It seems to have been first introduced into Europe, about the middle of the 17th century, by the Dutch,—and into England from Holland, in 1666, by Lords Arlington and Ossay. It was originally sold in this country for sixty shillings per pound, and was treated as a rare and high and dangerous luxury; and though strenuously denounced and vigorously opposed, it year after year got into increasingly extensive use,—and, at about the beginning of the 18th century, it became generally established as a culinary necessary of British life. It subsequently continued to be a vast and rapidly increasing department of the East India Company's imports to Britain; and, in recent times, it rose to a great and permanent augmentation by the opening of the Indo-Chinese ports to general commerce. The experimental cultivation of it was tried in Bengal so early as 1793,—and on a greater and more vigorous scale in 1835; the actual and extensive cultivation of it has for a considerable period been carried on in Assam and Cochin-China,—and promises to acquire great consequence in several of the Anglo-Indian provinces; and the amateur cultivation of it in the open ground, with the view of testing its possible adaptations to routine culture, has been tried in several parts of England, and in several countries of Continental Europe. The plant proves quite capable of withstanding the winter in the open ground in Britain, with the aid of a little protection when young; and it may admit of a very easy and extensive naturalization throughout the milder regions of Southern Europe; nor does it seem to possess any particular fastidiousness as to soil or situation or cultorial treatment; yet—on the mere ground of the far greater cheapness of labour in China than in Europe, combined with the fact of the extensive hereditary experience which the Chinese possess both in the department of cultivating the plant and in that of drying and otherwise preparing its leaves—it probably can nowhere be so grown in Europe as to yield marketable produce at as low a price as the tea imported from China.

Tea is cultivated, not in every part of China, but chiefly in a tract on the east side, called the tea country, situated between the 28th and 35th degrees of north latitude, and more particularly between the 30th and 33d, and possessing a mean temperature in November of 56° Fahrenheit at sunrise and 62° at noon. But in Japan, it is cultivated, not in any particular district, or in lands specially devoted to it, but in all parts of the country, around the border of corn and rice fields. The mode of cultivation in the two countries is very much the same. The plant thrives best on light stony soil; and is commonly sown in the month of February, in rows 4 or 5

feet asunder. From six to twelve seeds are deposited in each hole; for in consequence of their oiliness, they are apt to become rancid, so that a considerable proportion do not germinate. The plants require to be carefully weeded while very young; but are otherwise easily reared. Their leaves are not available for gathering till the third year after sowing; but they are then good and abundant. At seven years from sowing, the plants attain their full height, but they then have thinner and less valuable leaves than in the third and three following years; and at that time, they are generally cut over near the ground, so that they send forth an exuberance of new shoots, and may yield as strong, well-flavoured, and plentiful leaves as before; and, by this practice of cutting over, repeated at suitable intervals, they can be rendered fairly or fully productive during an indefinite number of years. The leaves are gathered either singly or in sprigs; and can be collected by a diligent worker, sometimes to the amount of ten or even fifteen pounds in a day, and on the average, to the amount of from four to six. The leaves are gathered at different seasons or upon different methods, according to the several varieties of the tea; and are torrefied in buildings adapted for the purpose, having a number of small furnaces, each about three feet high, with a large flat iron pan at the top.

Bohea is gathered first from about the middle till the end of April, next from about the middle of June till about the middle of July, and next from the beginning of August till the end of September; and if the demand be great, a fourth gathering is made later in the year, though at the serious risk of impoverishing next year's crop. The leaves are put into large baskets to dry, elevated to receive currents of air, or exposed to the sun, if not too intense, for a few hours, when they begin to impregnate the air; then they are what is called *tatched*, which is done by throwing each time about half a catty of leaves into a flat pan of cast iron, which is hot, and stirring them with the hand. They are then taken out and again put into the baskets, and rubbed with men's hands to roll them, after which they are again tatched in larger quantities, and over a slower fire; which being accomplished they are further fired in baskets over charcoal. This being completed, the tea is laid upon a table, and the useless or bad selected from it; but being a common tea, it is not so carefully examined as the other sorts. The best is of a small blackish leaf, and dusty, of a somewhat brackish taste; and it should be crisp. Reject what smells faint and disagreeable.

Congou requires great care in the making. The London dealers know three sorts of Congou teas, viz. Congou, Campoi Congou, and Ankay Congou. The first is a superior kind of bohea, larger leaf and less dusty. It should be chosen of a fresh smell, the taste less strong than bohea, to feel crisp, and easily crumbled. Those congous which run broken and dusty, of a heated smell, and faint unpleasant taste, should be rejected. Campoi congou is a superior kind of congou, but much resembling it, but fresher and of a cleaner flavour, not unlike souchong. Ankay congou receives its name from Ankay where it is propagated. The leaf is small and wiry, and of a burnt smell. At Canton it has a high flavour, which is lost in the course of the voyage. This tea is little esteemed in London.

Souchong, or Se-ow-chong, is made from the leaves of trees three years old, and where the soil is very good, of older leaves; but of the true souchong very little is produced. What is sold to Europeans for souchong is only the first sort of congou; and the congou is only the first sort of bohea. Upon a hill planted with tea-trees, one only may produce leaves good enough to be called souchong, and of these only the best and youngest are taken; the others make congous and boheas. The London dealers distinguish three species of souchong. Souchong, or what is commonly called so, should be crisp and dry, of a pleasant fragrant smell, and as free from dust as possible. When tried in water, the more reddish brown the leaves are the better, and the water of a lightish brown. It is sometimes of a high colour, and sometimes pale; but the tea, if good in other respects, should not be rejected on account of the colour. Avoid such as is broken, dusty, or foul, or that smells old and musty. Caper souchong takes its name from being rolled up something like a caper. The leaves of this should be chosen of a fine black gloss, heavy, of a fresh good smell, taste full flavoured and high. On being infused in water, it tinges of a bright reddish brown colour. Reject that which is dusty and broken, and of a faint smell. Padre souchong, or Pow-chong, is a very superior kind of souchong, having a finer taste, smell, and flavour. The leaves are larger and of a yellowish hue, not so strongly twisted. This tea is scarce, and difficult to be procured genuine. That which is small and broken should be rejected.

Pekoe, or Pé-how, is made from the leaves of trees three years old, and from the tenderest of them, gathered just after they have been in bloom, when the small leaves that grow between the two first that have appeared, and which altogether make a sprig, are downy and white, and resemble young hair or down. This tea is esteemed superior to souchong. It should be chosen with small white leaves, or flowers at the ends of the leaves; the more flower it has, the more it is esteemed. It has a peculiar flavour; and it greatly improves souchong on being mixed with it. That which is old, small, and broken, with little flavour, should be rejected.

Green teas are cured in the following manner:—When the leaves are gathered, they are directly tatched, and then very much rubbed by men's hands to roll them, after which they are

spread, to divide them, for the leaves in rolling are apt to stick together. They are then tatched very dry, and afterwards spread on tables to be picked; then they are tatched again, and tossed in flat baskets, to clear them from dust; they are then again spread upon tables, and picked, and then tatched for a fourth time, and laid in parcels, which parcels are again tatched by ten catties at a time, and when done, put hot into baskets for the purpose, where they are kept till it suits the owner to pack them in chests or tubs; before which the tea is again tatched, and then put hot into the chests or tubs, and pressed into them by the hand. When the tea is hot, it does not break, which it is apt to do when it is cold. Singlo tea being more dusty than hyson tea, is twice tossed in baskets; hyson only once. It appears that it is necessary to tatch these teas whenever they contract any moisture; so that if the seller is obliged to keep his tea any time, especially in damp weather, he must tatch it to give it a crispness, before he can sell it. It is a common opinion that the verdure on green teas is occasioned by their being dried on copper; but this seems entirely a mistake. The London dealers classify green teas into several species; and the first of these is Singlo.

There are two gatherings of Singlo tea, the first in April and May, the second in June; and each gathering is divided into three or more sorts. The first picking contains the largest and finest leaves, and is of course the best. Singlo is of a flattish leaf. It should be chosen of a fresh strong flavour; be of a light green colour when chewed; should feel crisp and brittle; and on infusion have none of the leaves turn brown or dark coloured. That which is yellow, of a large loose leaf, and dusty, should be rejected.

Twankay, or Tunkey, is a superior kind of singlo. It grows near the Hyson country, and is oftener tatched and picked than the common singlo. Twankay, like other singlo tea, is made into two or three sorts; and the best is sometimes sold for hyson of an inferior growth. It should be chosen with the leaves well twisted or curled; it ought also to have a burnt smell, not too strong but pleasant; and on infusion it should yield a paler colour than singlo. That which is yellow, and has a smell inclining to sulphur, should be rejected.

Hyson skin, or bloom tea, has its name from being compared to the peel or skin of the hyson tea, a sort of cover to it, consequently not so good. It consists of the largest, unhandsome, bad coloured, and uncurled leaves, that are picked out from the hyson tea. Hyson skin is a superior kind of green tea, of a round, knobby, brightish leaf; but great part of what is imported is of an inferior quality, of a yellowish open leaf, somewhat resembling singlo, and in consequence varies greatly in price. It should be chosen of a fresh smell, on infusion yield a pale yellowish green colour, and of a delicate taste, though somewhat of a burnt flavour. The more it approaches to hyson, the more it is esteemed.

Superior hyson skin intervenes between the common hyson skin and the hyson. It is said to be hyson tea a year or more old, which, after undergoing the process of tatching repeatedly, is brought to market a second time. Its appearance is much darker than hyson, with less bloom on it. Its smell is somewhat musty, and the taste has more of the brassy flavour peculiar to green teas, without any of the delicate aromatic taste of good hyson. On infusion, the water is darker coloured, and with less fragrance than hyson.

Hyson, or He-tchune, is the first crop of this tea. There are two gatherings of it; and each gathering is distinguished into two or more sorts. Hyson tea should be chosen of a full sized grain, of a fine blooming appearance, very dry, and so crisp, that with a slight pressure it will crumble to dust. When infused in water, the leaf should open clear and smooth, without being broken or appearing shrivelled,—which is one of the indications of old tea. It should give the water a light green tinge. The water should also have an aromatic smell, with a strong pungent taste. Those leaves which appear of a dyed yellowish green, or give the water a similar tinge, or rather a brownish hue, should be rejected; likewise that which appears highly glazed, which occasions it to yield a darker colour to water.

Gunpowder is a superior kind of hyson. This tea should be chosen round, resembling small shot, with a beautiful bloom upon it, which will not bear the breath. It should appear of a greenish hue, and a fragrant pungent taste. The chest of gunpowder is of the same dimensions as that of hyson; and the heavier it weighs, the better the tea is considered. Gunpowder tea is sometimes adulterated. An inferior kind of tea is dyed and glazed, to bear the appearance of the finest tea, but which, on infusion, is very inferior in every respect. This should be carefully avoided; likewise that of which the leaf is open and loose, the face of a darker hue or bloom, and that has a brassy unpleasant taste.

Chulan hyson is a peculiar kind of hyson-leaf, having the berries of a small plant, called by the Chinese chulan, mixed with it, which gives it a cowslip flavour, on which account it is sometimes called cowslip tea. It should be chosen of a yellowish leaf, a fragrant and perfumed smell, and when infused in water, of a strong cowslip flavour.

Ball tea is so called from the form into which it is made, being round, and nearly the size of a nutmeg, composed of the leaves of black tea, generally of the best kind, gummed together.

Brush tea is so called from the leaves being twisted into small cords, like pack-thread, about $1\frac{1}{2}$ to 2 inches long. Usually three of these are tied together at the ends by different coloured silks. They are made both of green and black tea.

The latest analysis of tea is that of Mulder; and is as follows:—

	Chinese.		Javanese.	
	Hyson.	Congou.	Hyson.	Congou.
Volatile Oil	0·79	0·60	0·98	0·65
Chlorophylle	2·22	1·84	3·24	1·28
Wax	0·28	0·00	0·32	0·00
Resin	2·22	3·64	1·64	2·44
Gum	8·56	7·28	12·20	11·08
Tannin	17·80	12·88	17·56	14·80
Theine	0·43	0·46	0·60	0·65
Extractive	22·80	19·88	21·68	18·64
Apotheme	—	1·48	—	1·64
Ext. obtained by hydrochloric acid	23·60	19·12	20·36	18·24
Albumen	3·00	2·80	3·64	1·28
Fibrous Matter	17·08	28·32	18·20	27·00
	98·78	98·30	100·42	97·70
Salts included in the above	5·56	5·24	4·76	5·36

"According to this analysis," remarks Dr. Pereira, "green tea contains more tannin than black tea. This accords with every-day experience, as well as with the experiments of Mr. Brande; but it is opposed to the results obtained by Sir H. Davy and Frank, both of whom state that black tea is the most astringent. It is probable, therefore, that the amount of tannin in different teas is subject to variation.

"The substance called theine, or theina, is a crystalline salifiable base, discovered some years since by Oudry, and since found to be identical with caffeine, obtained from coffee. Its formula is $C_8\ H_5\ N_2\ O_2$. It exists in tea in combination with tannic acid. Hot water extracts the tannate of theina as well as free tannic acid; but by cooling, both of these substances almost entirely precipitate. According to Mulder, theina is not to be regarded as the principle which confers on tea its peculiar or characteristic properties. Its action on the system is not very obvious. He gave half a grain to a rabbit; the animal ate but little the next day, and aborted the day after. Liebig has suggested that it may contribute to the formation of bile. Without entering minutely into the medicinal action of caffeine (theine) he observes, it will surely appear a most striking fact, even if we were to deny its influence on the process of secretion, that this substance, with the addition of oxygen and the elements of water, can yield taurine, the nitrogenised compound peculiar to bile:—

1 atom Caffeine or Theine	=	$C_8\ N_2\ H_5\ O_2$
9 atoms Water	=	$H_9\ O_9$
9 atoms Oxygen	=	O_9
= 2 atoms Taurine	=	$2\ (C_4\ N\ H_7\ O_{10})$
		$C_8\ N_2\ H_{14} O_{20}$

The same authority adds that $2\frac{8}{10}$ths grains of caffeine (theine) can give to an ounce of bile the nitrogen it contains in the form of taurine. If an infusion of tea contain no more than the $\frac{1}{10}$th of a grain of caffeine (theine), still if it contribute in point of fact to the formation of bile, the action even of such a quantity cannot be looked upon as a nullity. Neither can it be denied, that in the case of an excess of non-azotised food, and a deficiency of motion, which is required to cause the change of matter in the tissues, and thus to yield the nitrogenised product which enters into the composition of bile, that in such a condition the health may be benefitted by the use of compounds which are capable of supplying the place of the nitrogenised product produced in the healthy state of the body, and essential to the production of an important element of respiration. In a chemical sense—and it is this alone which the preceding remarks are intended to show—caffeine or theine, asparagine, and theobromine, are, in virtue of their composition, better adapted to this purpose than all other nitrogenised vegetable products. The action of these substances, in ordinary circumstances, is not obvious; but it unquestionably exists. These views, though quite hypothetical, are highly ingenious and interesting.

"The peculiar flavour of tea depends on the volatile oil, which is lighter than water, and has a lemon-yellow colour, and the taste and smell of tea. Alone, it acts as a narcotic; but in combination with tannin, as a diuretic and diaphoretic. It is extracted from tea by hot water, in which, however, it is not always equally soluble, its solubility being modified by the other constituents.

"The following is the composition of the ashes of black tea:—

	Chinese.	Javanese.
Potash, Sulphate, Phosphate, and Muriate of Potash	2·84	3·40
Oxide of Iron, Carbonate, Sulphate, and Phosphate of Lime, and Carbonate of Magnesia	1·72	1·64
Hypermanganate of Potash	Traces.	—
Silica	0·68	0·32
	5·24	5·36

"Notwithstanding the extensive employment of tea in this country, it is no easy matter to ascertain its precise effects on the constitution. Its astringency, proved by its chemical properties, depends on the presence of tannin. Of this quality we may beneficially avail ourselves in some cases of poisoning: as by poisonous mushrooms, by opium or laudanum, or by any other vegetable substance containing a vegetable alkali, with which the tannin combines. Schwann found that tannin throws down a precipitate from the artificial digestive liquids, and renders this fluid inert. Does the copious use of strong tea, therefore, immediately after a meal, impede the process of digestion? The peculiar influence of tea, especially of the green variety, over the nervous system, depends on the volatile oil above referred to. This influence is analogous, in some respects, to that of foxglove; for both green tea and foxglove occasion watchfulness, and act as

sedatives on the heart and blood-vessels. These effects of tea are familiar to most persons. It is a common practice with those who desire nocturnal study to use tea; and, on the same principle, it may be employed as an anti-soporific to counteract the effects of opium and intoxicating liquors, and to relieve the stupor of fever. As a diluent and sedative, it is well adapted for febrile and inflammatory disorders, and most persons can bear testimony to its good effects in these cases. To its sedative influence, also, should be ascribed the relief of headache sometimes experienced by the use of strong tea. In colds, catarrhs, and slight rheumatic cases, warm tea is used as a diluent, diaphoretic, and diuretic. Strong green tea produces on some constitutions, usually those popularly known as nervous, very severe effects. It gives rise to tremor, anxiety, sleeplessness, and most distressing feelings. On others, however, none of these symptoms are manifest. Part of the ill effects sometimes ascribed to tea may be owing to the use of so much aqueous liquid—to the temperature of the liquid—to milk and sugar used with it—or to the action of the tannin on the digestive liquid. But, independently of these, tea possesses a specific and marked influence over the functions of the brain, not referable to any of the circumstances just alluded to. Weak tea rarely disagrees with the invalid, and is admissible in a variety of maladies, in most of which it proves refreshing and agreeable. It is well adapted for febrile and inflammatory complaints; and is particularly valuable when we are desirous of checking sleep. Moreover, if the suggestions of Liebig be correct, tea is by no means to be considered as a mere diluent, but as possessing nutritive powers of no mean kind."

TEAK-WOOD,—botanically *Tectona*. An evergreen, tropical timber-tree, of the verbena family. It is a native of many parts of India, and commonly attains a height of about 100 feet. It constitutes a genus of itself; and is specifically called *grandis* or the great. Its timber possesses vast economical value in India, and is generally used in ship-building, house-carpentry, and furniture-making. That of the Malabar coast is the most esteemed; and that of the Coromandel coast, near the banks of the Godavery, holds the second place. The plant was introduced to the botanical collections of Britain in the latter part of last century.

TEAL,—scientifically *Anas Crecca*. A British bird of the duck genus. It is an early and constant winter inhabitant of Britain, arriving in the latter part or about the end of September, and departing at a somewhat advanced period of spring. It is the smallest of our ducks, but a very prettily marked species, and one of the best as an article of food. The total length of the full-grown male is 14½ inches; the forehead and a narrow band on the top of the head have a rich chestnut brown colour; the part backward from the eye is marked with a patch of rich glossy green; the neck and the upper part of the back display a mixture of black and white in transverse lines; the breast and the belly are white; and the lower part of the front of the neck is partially marked with circular black spots.

TEAM. Two or more horses, oxen, or other beasts of draught drawing together the same agricultural implement or wheeled vehicle.

TEA-PLANT. See Tea.

TEASEL,—botanically *Dipsacus*. A genus of herbaceous calyciflorous plants, constituting the type of the natural order Dipsaceæ. This order is very nearly akin to the Compositæ, and possesses a very similar habit and general appearance. All its plants are herbaceous, and produce their flowers in heads. All are capable of very easy cultivation; some are eminent beauties of the flower-border; and a few possess economical or medicinal properties. About 120 species, belonging to 8 or 10 genera, occur in the wastes and gardens and botanical collections of Britain; and excepting about 10, which require the protection of the greenhouse, all are hardy.

The teasel genus comprises three indigenous species, four introduced species, and several known unintroduced exotic species. Its flowers are monopetalous, tubular, and four-cleft, and, together with the proper calyxes, stand on the summit of the single seed, which is terminated by an entire, cross-shaped crown; its involucrum or common calyx is many-leaved; and its receptacle is conical, and has long, rigid, entire chaff or paleæ. All the seven species in Britain are hardy biennials, propagable from seeds; they vary in height from 3 to 7 feet, and, for the most part, bloom in July; and four are purple-flowered, one blue-flowered, and two white-flowered.

The fuller's teasel, *Dipsacus fullonum*, occurs about the hedges of several parts of England, but is rare in its wild state, and has long been cultivated in the vicinity of some manufacturing towns, for its use in raising the nap of woollen cloths. Its root is fleshy, branched, and tapering; its stem is erect, strongly furrowed, prickly, leafy, branched at the top, and about six feet high; its leaves are sessile, entire, and beset with small scattered spines on their margins and surfaces,—and those of the stem are opposite and joined together at the base; and its flowers are very numerous, and have a whitish colour, with pale purple anthers, and grow in close, obtuse, conical heads, with the chaff or intermediate scales bristly at the edges, and rigid, spiny, and recurved at the points, and bloom in July. The scales are just strong enough to raise the wool of cloth, and give way before they can injure it; and they are used by being fixed round the circumference of a large broad wheel or cylinder, which revolves in contact with the cloth. Many mechanical inventions have been introduced to supersede them; but all have proved bad substitutes, and been found either inefficient or in-

jurious. From 1,500 to 2,000 heads of teasel are required for dressing one piece of cloth; and they are repeatedly used in different parts of the process.

The soil suitable for the field cultivation of fuller's teasel requires to be of rather strong texture or a rich superior loam, and to be in a state of very fine tilth and of thorough cleanness. A practice prevails in some places of raising teasel in a three years' course along with coriander and caraway; but this practice is seldom so good as that of raising the teasel alone. See the article Caraway. In March, land intended for teasel is brought into the highest possible state of tilth; about May-day, the seed is sown, either broad-cast or in drills, at the rate of from one to two pecks per acre; during the summer, the land is three or four different times worked over with long, narrow spades, to destroy all weeds; in November, the plants are adjusted by thinnings and fillings-up to distances of about a foot asunder; and if many more plants are taken up in the thinnings than are wanted in the fillings-up, they are transplanted on another piece of ground, previously prepared for their reception. The broad-cast method was formerly in general use; but the drill system is now found preferable, and possesses these two among other advantages, that it saves about one-fourth of the seed, and that it effects greater regularity in the original distances or saves much of the labour and cost of thinning and transplanting,—together with the incidental advantage, that plants which are never removed produce better heads than those which are transplanted. In the July of next year, the uppermost heads begin to bloom; and in the following month, they lose their blossom and become ripe. The gathering is performed at three successive periods, at intervals of about a fortnight, by means of a peculiarly constructed knife; and consists in cutting off the heads and tying them into handfuls. The cut heads require to be carefully kept from exposure to rain, and carefully and regularly dried; and either they are suspended in temporary sheds erected for the purpose in the field, or they are carried direct to the barn, and brought out and exposed to the sun on every clear dry day; and when they have become quite dried, they are separated into three kinds called kings, middlings, and scrubs, and made into packs of each 9,000 kings and 20,000 middlings,—the scrubs being of small value. An average or pretty good crop yields about 15 or 16 packs per acre; but a prime crop far exceeds this, and a very bad crop may be a total blank.

The wood or wild teasel, *Dipsacus sylvestris*, is very common about the moist hedges and road sides of some parts of Britain; and has been thought by some persons the normal or typal form, or remote origin, of the fuller's teasel. It is nearly or quite as tall as that species, but less robust. Its leaves are opposite and serrated; its flowers resemble those of the fuller's teasel, and bloom about the same period; its receptacle-scales are straight; and its common calyx is inflexed and longer than the head.

The small teasel, or pilose teasel, or shepherd's staff, *Dipsacus pilosus*, grows wild in moist shady places upon a calcareous soil. It is a useless but not troublesome weed; and it at the same time possesses sufficient beauty to deserve a place in the back-rows of the flower-border. Its stem is angular, leafy, branched, rough, with ascending hooked bristles, and 3 or 4 feet high; its branches are spreading; its leaves are stalked, ternate, ovate, pointed, strongly serrated, and of a deep green colour; its flowers grow in small globular heads, and have a white colour, and bloom in August; and its common calyx is deflexed and about the same length as the head.

TEATHING. Eating off turnips, upon young wheat crops, in the early parts of spring, by sheep or bullocks.

TEA-TREE. See Tea.

TECOMA. A genus of ornamental, ligneous, exotic plants, of the trumpet-flower order. It comprises one hardy deciduous climber, of commonly about 30 feet in height, three somewhat tender evergreen climbers of 8 or 12 feet in height, one greenhouse deciduous upright shrub of about 6 feet in height, and 8 hothouse evergreen upright shrubs of from 6 to 12 feet in height; and all these occur in British collections,—about one half were formerly included in the genus bignonia,—most have either yellow or orange-coloured flowers,—and the greater number love a soil of peaty loam, and are propagated from cuttings.

The rooting tecoma, or scarlet trumpet-flower, *T. radicans*, called by the old botanists *Bignonia radicans*, is the hardy climbing species, the best known one, and the most interesting. It is a native of Carolina, Virginia, and Canada; and was introduced to Britain in 1640; and has long been regarded by the most eminent British gardeners, and by landscape gardeners, as a plant of surpassing beauty. Its stem climbs to an amazing height upon advantageously situated edifices or trees, and strikes roots from the joints into whatever is near it; its leaves grow opposite by pairs at the joints, and are pinnate, and comprise each about four pairs of leaflets and a terminating odd one; its leaflets have a fine green colour, and are deeply cut in the edges, and drawn out into a long point; and its flowers come out in bunches at the ends of the branches, and are large and trumpet-shaped, and have a fine red colour, often approaching to orange, and bloom in July and August, and make a magnificent show.—A smaller variety, *T. r. minor*, differs from the normal plant, in the comparative smallness of the leaves and the flowers, and in the less tendency of the latter toward an orange colour, or in their having a purer and brighter red.—Both kinds may be raised, tediously, from seeds; or, more expeditiously, from cuttings of

the bottom part of the youngest shoots; or, best of all, from rootings of the shoots, laid upon the ground, and covered with a little mould.

TECTONA. See Teak-Wood.

TEDDING. See Haymaking.

TEEDIA. A small genus of ornamental, herbaceous, South-African plants, of the figwort family. Two species, the shining and the pubescent, both purple-flowered biennials of about two feet in height, the former blooming from April till July, and the latter from May till October, have been introduced to Britain; and they love a soil of peaty loam, and are propagated from cuttings.

TEESDALIA. A small genus of handsome, white-flowered, hardy, annual plants, of the cruciferous order. The naked stalked or irregular species, *T. nudicaulis*, grows wild in the pastures of some parts of Britain. Its root is slender and tapering; its stems rise in groups from one root, and are erect or spreading, and about 6 inches high,—the central one quite straight and always naked; its leaves are numerous, and spread on the ground, and are partly entire but chiefly pinnatifid; and its flowers grow in small corymbs, and have unequal petals, and naturally bloom from May till July.—The regular species, *T. regularis*, was introduced from the South of Europe in 1824; and is smaller than the preceding; and blooms from February till May.—Both species thrive in any common soil, and are very suitable for rock-work, and need only to be once sown, and will afterwards propagate themselves.

TEETH. The teeth of most of the higher orders of mammals—particularly those of man, of the quadrumana, of the carnivora, of the pachydermata, and of the hornless ruminantia—notwithstanding great and signal differences in the chief groups or genera, possess certain important common characters of both classification and composition,—or, in every case, comprise incisors, cuspidates, and molars, and consist of enamel, ivory, and osteous cement. They have different forms and arrangements and relative numbers in different genera, to suit to a nicety the special wants and feeding-habits of each animal; yet, in all instances, though more or less vigorously according to the saliency of their points and the refractoriness of the substances on which they operate, the incisors cut or nip, the cuspidates tear or lacerate, and the molars grind or bruise or pulverize. The three classes, as they exist in the horse, may be taken as a familiar specimen, and bear the popular names of nippers, tushes, and grinders, and have been described in our article Age of Animals. The enamel, the ivory, and the osteous cement, aggregately adapt the teeth to withstand the attrition of eating, the chemical action of substances incidentally lodged in the interstices, the action of the atmosphere, and the diversity of organic forces within the exposed and the unexposed parts of the teeth; and they are differently proportioned to one another, not only in the teeth of different species of animals, but in the different classes of the teeth of the same species, and in the different parts of the same tooth. The aggregate substance of the teeth enjoys incomparably more power of resisting both mechanical and chemical agency than the aggregate substance of common bone; the crown or exposed and working part of each tooth enjoys vastly more hardness and exterior strength than its root or unexposed and comparatively quiescent part; and the working surface of the crown, whether it consist of edge or points or laminæ, enjoys exactly the amount of superior hardness or intrinsic diversity which fits it for performing its mechanical functions in the best possible manner with the least possible wear.

The enamel is by far the densest and hardest of the three constituents of teeth; and will yield fire with steel like flint, and is not easily acted on by even the best tempered files. It never occurs alone, but always as a coating to the other constituents; and it serves so to temper the teeth, as steel tempers iron, that they may resist attrition, and continue unworn as long as the wants of the animal may require. In the incisors and cuspidates of the horse, it covers all the exposed portion; and in the grinders, instead of covering the surface generally, it forms distinct intertextured layers. It is supposed to consist of 78 per cent. of phosphate of lime, 6 of carbonate of lime, and 16 of gelatine; it has a crystalline compactness, but a minutely or very finely fibrous structure; it is secreted from the membrane of the pulp; and it does not contain any cartilage, and is capable of complete solution in diluted nitric acid.—The ivory is very considerably softer than the enamel, yet harder than common bone; and it differs from the latter principally in containing a greater proportion of phosphate of lime, and in some instances in containing fluorate of lime. It has a fibrous structure; and is secreted from the early pulp, and forms the rudimental and early portions of the teeth.—The osseous cement is softer than the ivory, and contains a large proportion of animal matter, and somewhat nearly resembles common bone. It is regarded by some naturalists as an ossification of the secreting membrane of the enamel; by others, as a specific secretion, like the enamel itself; and by others, as a correlative secretion with the enamel from one of two layers of a membranaceous capsule which surrounds the pulp of the ivory.

Two sets of teeth are given to man and the greater number of quadrupeds,—the one temporary, and commonly called shedding or milk teeth,—and the other permanent, and commonly called adult or full-grown teeth. The jaws grow much faster, and mature much earlier, in proportion, than the general system of the body; and therefore a temporary and comparatively small set of teeth is given them to suit their infant state,

and another and comparatively large set to suit their matured state. The interiors, the sockets, and the muscular adjuncts of the teeth are pervaded by ramifications of blood-vessels, nerves, and absorbents,—the first to form and maintain the secretions, the second to maintain sensation and vital energy, and the third to withdraw exhausted or useless matter from about the roots and the interior.

Caries or rotting of the substance of the teeth occurs more or less in all animals, but is peculiarly frequent and virulent in man, and very specially so in those members of the human family who think themselves most highly civilized. One cause of this disease in man is the want of a due degree of dental action, occasioned by the luxuriousness or soft forms of food; another is the rapid and mighty whirl of chemical forces acting on the teeth from the great diversity and rapid succession and piquant nature of the articles of diet; and a third and chief is the adherence to their teeth or their interstices of small particles of easily decomposable substances, such as flesh meat or animal sauces, or almost any of the mixtures of the most relished dishes. Decomposition of the particles is rapidly effected under the combined action of the heat and moisture of the mouth and the oxygen of the atmosphere; and an acid results which immediately attacks the phosphate of lime in the teeth, and after a series of times, so far accomplishes its decomposition as to set the teeth perceptibly a-decaying. A little hole is now made which henceforth constantly lets in the atmospheric air, the salivary secretions, and the decomposing particles of adhering food; and unless this hole is promptly stopped with some composition similar to what is used by dentists, a rapid decay of the entire tooth, on to its destruction, is inevitable.

One of the greatest enemies to human teeth is the concretion denominated tartar, which forms upon them like a crust, and would encase them wholly were there no impediment. Of the nature of this tartar and how it is formed a great deal has been written; but the whole that has been advanced and urged, sometimes very authoritatively and with great dogmatism, only goes to prove that the writers knew nothing of the matter. Of late, since the wonders of the world of animalcules, like a new creation, have occupied the attention of the learned,—since it has been shown that myriads of living creatures exist in a single drop of water,—since it has been conjectured by some hyper-hypothesists that the whole creation is made up of animalcules,—since mineralogy and general physics have entered the nursery, and Greek and Latin form a necessary part of a young lady's education, it has been the fashion to consider the tartar that is formed upon the teeth, as the work of animalcules,—as in fact nothing more than a mass of cells built by minute and invisible polypi, a sort of miniature coral reef, or wall of madrepore rock, like those raised by polypi in mid-ocean, and which serve as the foundation stones of islands. If this be true, whence come these diminutive creatures? —where and how are they bred, and what is their pedigree? All however that we really know on this head is, that the substance termed tartar does actually exist on the teeth, to which, if not removed, it is very injurious; and that the rapidity of its formation frequently depends upon the state of the stomach. In some idiosyncrasies, it is not formed at all; in others, only a little; in others, a great deal. Whenever it does appear, it should be removed; yet, even where there is an idiosyncratic tendency to its accumulation, it will not have time to form if the teeth were properly attended to,—a thing requiring more of the minuteness of attention than of actual trouble. If tartar be allowed to accumulate, which it almost always does in the permanent absence of tooth-brushes and tooth-powder, it not only gradually loosens and destroys the teeth, but corrodes the gums, and reduces them to a state of disease frequently mistaken for scurvy, even by medical men; and at length it occasions the total destruction of the teeth, and a sad unsightliness of the gums, with no other remedy left but to encase the latter in an artificial socket bearing a set of artificial teeth.

The diseases of the horse's teeth, as well as the proper treatment of them, differ considerably from those of man. Feverishness, loss of appetite, diarrhœa, and a number of other and widely dissimilar affections, either arising wholly from difficulty of dentition, or more or less severely aggravated by it, are so frequent in young horses, that, whenever any of them occurs, and is found on examination of the mouth to be accompanied with prominence and pushing of the tushes, a crucial incision ought to be made upon the gums. "In this way," says Mr. Percivall, "I have seen catarrhal and bronchial inflammations abated, coughs relieved, lymphatic and other glandular tumours about the head reduced, cutaneous eruptions got rid of, deranged bowels restored to order, appetite returned, and lost condition repaired."—The grinders of more advanced horses are apt to become roughened in the edges from irregular growth or from irregular wearing of the enamel, and may in this state give rise to bad ulcers in the mouth, and ought to be rasped smooth.—Part or whole of a back tooth or other grinder sometimes grows to a higher level than the rest of the teeth, and penetrates the bars above it, and causes serious ulceration, or interferes so constantly and ruinously with mastication as to occasion a general pining for want of due food; and whenever any such over-growth is detected, it ought to be reduced to the level of the other teeth by means of a saw.—A general irregularity in the surface of the grinders, though not marked by any very observable prominence in any one part, is sometimes so great as to occasion what is called quidding, and to constitute

great and almost incurable unsoundness. See the article QUIDDING.—Caries, though incomparably rarer in the horse than in man, yet sometimes occurs with such virulence as not only to destroy one tooth, but to communicate the rotting to neighbouring teeth and even to the jaw; and every carious tooth should be extracted,—not with the hammer and the punch, but with a keyed instrument similar to that used upon the human subject, but of a larger size.

TELEPHIUM. See ORPINE.

TELLURIUM. A rare metal, discovered toward the close of last century. It occurs in its proper metallic state chiefly in combination with silver and gold. It has a lamellated texture, a strong metallic lustre, and a tin-white colour merging toward lead-grey. It is very brittle, fuses at a heat below redness, volatilizes at a red heat, and has a density of 6·115. It ignites before the blow-pipe, burns with a greenish-blue flame, and disappears in grey, pungent, inodorous fumes. An oxide is formed during combustion, possessing the properties of a grey colour, fusibility at a red heat, and violent decomposableness before the blow-pipe. A soluble nitrate of the oxide results from the action of nitric acid upon the metal; and a volatile chloride, constituting a white crystalline solid at common temperatures, is formed by passing chlorine over moderately heated tellurium.

TELOPEA. A small genus of ornamental, exotic, ligneous plants, of the proteaceous order. The most showy species, *T. speciosissima*, was introduced to Britain in 1789 from Australia; and is one of the most lovely evergreen shrubs of the greenhouse or the conservatory. It has commonly a height of about 10 feet, and carries splendid scarlet-coloured flowers from May till July. Its habit of growth is firm and upright; and its general appearance, at all seasons, is handsome and imposing. It loves a soil of sandy peat, and is propagated from cuttings; but it is very liable to perish from too great cold in winter, or from excess or deficiency of water at any season, or from other causes which assail it in common with other proteaceous plants,—and, in consequence, it occurs in comparatively few collections, and is often found in a sickly state.

TEMPERATURE. The subtle principle or imponderable fluid whose degrees and fluctuations constitute temperature, is noticed in the article CALORIC; the instrument by which the scale, the intensities, and the changes of temperature are measured, is described in the article THERMOMETER; the part which temperature acts in the general phenomena of weather, is noticed in the article METEOROLOGY; the connexions which it sustains to the most conspicuous of particular meteorological phenomena, are pointed out in the articles EVAPORATION, CLOUD, FREEZING, HOAR-FROST, DEW, and RAIN; the offices which it performs upon the constituents of the air, and the relations which it bears to their various conditions, are mentioned in the article ATMOSPHERE; the control which it exercises over the aggregate adaptations of different zones and localities to the sustenance of organic existence, is discussed in the article CLIMATE; the part which it plays in the interior and vital economy of animals is described in the article ANIMAL HEAT; the offices which it serves in the exterior circumstances of animals, are mentioned in the articles FEEDING OF ANIMALS and SHELTER; the resistances which it makes to the healthy transmigration of any of the lower animals from their native region to a hotter or a colder one, are pointed out in the article ACCLIMATATION OF ANIMALS; the relations which it sustains to different latitudes of the globe and to different elevations above the level of the sea, and the determination which it exercises over the geographical distribution of plants, are treated in the article ALTITUDE; the offices which it performs upon plants, or the relations of stimulation, chemical action, growth, and resistance which it sustains to them, are noticed in the articles ORGANIC CHEMISTRY, AGRICULTURAL CHEMISTRY, GERMINATION, MANURE, SHELTER, BARK-BED, ACCLIMATATION OF PLANTS, and many others; the artificial raising and regulating of it in horticultural buildings, are discussed in the articles HOTHOUSE and GREENHOUSE; and the increasing and maintaining and modifying of it within the soil of fields, are pointed out in the articles DRAINING, FARM-YARD MANURE, and some others. Only three additional branches of the subject require to be discussed,—the general relations of temperature to the soil and to the meteorological conditions of the atmosphere,—the relations of the grasses to the temperature of different climates and of different years,—and the relations of exotic plants to the different temperatures of the soil and the air of gardens; and the second and the third of these are topics of great practical interest, to respectively the farmer and the gardener, and the first to all classes of persons whatever who are resident in the country; and we shall notice the second in the words of a writer in the 10th volume of the Quarterly Journal of Agriculture, and the third in those of a writer in the 13th volume of the Gardener's Magazine.

Humboldt, La Place, and many other modern philosophers, consider the fact of an internal heat in the earth as fully established, and they ascribe to it the origin and phenomena of volcanoes in connexion with metallic bodies, and with access of water to supply oxygen and hydrogen. At 8 feet deep, the annual temperature varies only from 5° to 7°; and at 4 feet, from 10° to 12°; while at one foot it ranges from 19° to 20°,—and in the open air it varies from 50° to 60°. At the depth of about 40 or 50 feet, the temperature of the earth is the same in winter and summer, apparently colder in summer, and warmer in winter; and the earth is believed to increase in heat, a degree in every 15 or 20 yards depth. In the

Catacombs at Paris, the thermometer through the year is between 52° and 54°, while on the surface it varies from 90° to 0° In Mexican mines it stands constantly at 74°. Depths of undisturbed air are like water. In a silver mine in Norway, 300 feet deep, the bottom is covered with snow; and so in other deep caves. While the air above snow is 70° below the freezing point, the surface of the ground below the snow is only 32°. It has been proved by experiment in latitude 56° 10′, by keeping thermometers fixed in the ground at various depths, that frost does not penetrate so deep in the earth as a foot; that at the depths of one, two, and three feet, the lowest temperature, during two years, was at one foot 33°, at 2 feet 36°, and at 3 feet 39°, while the highest was at one foot 35°, at 2 feet 52° 5′, and at 3 feet 52°. By other observations at one foot it varies 25° in the year, at 2 feet 20°, at 4 feet 15°, at 8 feet 9° 5′, and at 31 feet, 2° 7′; while at 40 or 50 there is no variation. In the deepest coal-mine in England, the mean annual temperature at 400 yards below the surface is 77°, and at 300 yards 70°; while at the surface it is but 48°, being about 1° of increase for every 15 yards. This explains the origin of hot springs, for at 3,300 yards the heat would be equal to boiling water, taking 20 to a degree. The heat of the Bath waters is 116°; hence they would appear to rise 1,320 yards. At great depths in the sea, as 4,000 feet, the difference is from 15° to 22° between the air and the water at that depth; and at 4,680 feet, the water is 26°, while the air is 48½°. By experiments made at the observatory of Paris, for ascertaining the increase of temperature from the surface of the earth towards the interior, 51 feet deep corresponds to the increase of 1°. Hence the temperature of boiling water would be at 8,212 feet under Paris. The mean annual temperature of the whole earth at the level of the sea is 50°. For different latitudes, it is as under, the third column showing the height in feet of constant freezing in those latitudes.

	Degrees.	Feet.
Equator	84·2	15,000
lat. 10	82·6	14,700
20	78·1	13,300
30	71·1	11,500
40	62·6	9,000
50	53·6	6,300
60	45	3,800
70	38·1	1,700
80	33·6	450

The mean heat at the equator is 84·2°, and at 45° it is 58·1°. Of 10,000 rays falling perpendicularly, 8,100 reach the earth,—7,000 at 50°, 2,800 at 7°, and 5 at 0°. Water seldom freezes till the meridian altitude of the sun is less than 40°. When the sun is in Aries and Libra, the relative heat of the equator, according to Humboldt, is taken at 1,000; at 20° is 940; at 40° is 750; and at 60° is 590. But when in Cancer or Capricorn, it is, for the same hemisphere, at 0°, 9,117; at 20°, 1,008; at 40° and 50°, 1,150; at 70°, 1,159; and at 80° and 90°, owing to sunshine for six months, 1,250.

The temperature in equal latitudes is from 4° to 8° less in the southern hemisphere; and this difference is supposed to arise from the extended surfaces of water, and from the sun passing through the southern signs 7¾ days less than the northern. The climate of the southern hemisphere is more equable than that of the northern. In May, at Cape Horn, latitude 56°, our November vegetation is flourishing. The sea is colder in the south, and ice extends 400 or 500 miles further from the south pole than from the north. There are currents from the poles towards the tropics, and then from east to west, in conjunction with the trade-winds. In latitude 75°, where the mean temperature is only 37°, only moss, lichen, dwarf willow, and sorrel grow. The earth, from the equator to the poles, resembles mountains in their kinds of vegetation from the base to the summit. Humboldt says the proportions in variety are, in the tropics 12; temperate zones, 1; and frigid, 0·1. The cold and heat of climates depend also on the vicinage of seas.—At Moscow the thermometer ranges from 6° to 70°, but at Copenhagen, in the same latitude, only from 27° to 65°; so at Vienna it ranges from 26° to 70°, but on the French coast, in the same latitude, only from 41° to 67°. In the Gulf of Guinea the thermometer rises to 130°; and Humboldt thinks that in the air it can never rise above 140°; at sea it never rises above 85° or 88°. The average heat at London in the first 16 years of this century was 50·93. The hottest day from 1774 to 1837 was in July, 1808, being 93·5; and the coldest, 25th December, 1796, 2° below zero. In 1830, the highest point of the thermometer was 90° in June, and the lowest 11° in January. The wettest month was 2·516 in July, and the driest 0·746 in February. In the past century, the severe frosts in England were in the winters of 1708, 1715, 1739, called the hard frost, 1742, 1754, 1776, 1788, 1796, and 1813. The highest temperature in the sun's rays at London is 154°; the highest of the air in the shade 90°; the mean temperature of the air 49½°, lowest 11°, and on the earth's surface 5°. In the counties round London, the mean temperature and rain in every month is as under:—

	Degrees.	Inches.
January	36·1	1·483
February	38·0	·746
March	43·9	1·44
April	49·9	1·786
May	54·0	1·853
June	58·7	1·83
July	61·0	2·516
August	61·6	1·453
September	57·8	2·193
October	48·9	2·073
November	42·9	2·4
December	39·3	2·426

The 14th January, on an average of years, is the coldest day in the year. The mean daily course

of temperature of the atmosphere is the same at all hours. According to a yearly mean, the coldest hour of the day, in Europe, is 5 o'clock in the morning, and the warmest hour of the day is from 2 to 3 in the afternoon. The rise is most considerable some hours after the minimum; the fall, some hours after the maximum. The heat increases for 9 to 10 hours, decreases for 14 to 15 hours. The greatest daily range of temperature in Europe takes place in July, and the least in December. The average temperature of the winter months in England is about 40°, and of the summer months 65°. Devonshire and Cornwall are about 4° warmer than London. The annual average of the thermometer at the north and south points of England, Carlisle and Sandwich, is 48° and 50°; the maximum in 1820 was 78° and 83°, and the minimum was 12° and 27°. The mean temperature of Ireland varies from 47° to 53°. At Kinfaun's Castle, in Scotland, latitude 56° 23′, the mean temperature for 1830 was 47·626; the rain 30·85 inches; the coldest day 10°; and hottest 79°; barometer from 30·53 to 28·73. In Leeds, Yorkshire, the thermometer was, July 18, 1825, at 92°; June 25, 1826, at 93°; and January 2, 1827, at 11°. The thermometer in Italy ranges between 75° and 96°; and in winter seldom descends below 40°, except in the mountains in the higher Apennines, where it falls to 20°. In New South Wales, the coldest month averages 54°, and the hottest 75°; it rains 100 days in the year; the north-west wind is a scorching sirocco; the air is generally dry, but the night dews are heavy. At the volcanic islands of the Gallipogos, half a degree north of the equator, the daily temperature is from 74° to 91°. The Red Sea is as hot as any part of the world; the thermometer ranges in 14 hours from 94° to 112°; from Babelmandel to Suez, the coast for 40 miles inland is a dry sand, without a blade of grass or drop of water. The cold at Tabreez in Persia, is so intense in February that persons are often frozen to death. The average heat of Boston is 47·3°; of Philadelphia, 53·7°; of Washington, 58·1°; of Detroit, 47·4°; of Cincinnati, 56·8°; of Pittsburgh, 54·2°; of New Harmony, 56·69°; of Charlestown, 57° to 60°; of Richmond, 56·1°. The temperature is so variable in South Carolina, that the thermometer sometimes varies 50° in 24 hours; it ranges no less than 83° in the year; the rain averages 50 inches. Sudden changes of temperature prevail in Africa; one is recorded of 27° in 24 hours. In Siberia and Hudson's Bay, mercury sometimes becomes solid, proving the cold to be 39° below zero; wine and spirits become a spongy mass of ice. At Bear Lake, Captain Franklin, on 7th February, found the thermometer at 58° below zero; and for two days it had been 57·5°. In the latitude of London, America is 13° colder than Europe; and in 40° latitude, is 8·6° colder than Europe. The mean temperature, according to Parry, for the 6 winter months, was at

	Latitude.	Temperature.
Winter Island	66° 30′	11° 7′
Igloolik	69° 20′	18° 3′
Melville Island	74° 45′	24°

No snow fell at Melville Island, and only 8 inches at Winter Island. An iceberg, seen by Parry, was above 250 feet out of the water, and therefore 1,800 feet thick. Spring is the most rapid in the Arctic regions. The snow disappears, and birds of passage re-appear; then, within a few days, the trees burst into foliage, the ground is covered with flowers, and mosquitoes are thawed in millions, while horseflies, sandflies, &c., render summer less comfortable than winter. Spiders, frogs, fish, &c., frozen and as brittle as ice, revive with the thaw.

In the temperate zone, the annual evaporation is 37 inches; but in the tropics from 90 to 100; and the mean quantity of rain is in the same proportion. In latitudes 46°, 47°, and 48°, the heat at sunset is the mean of the day. The mean quantity of water held in a cubic foot of air, in this climate, is 3·789 grains. All the moisture in the atmosphere is equal to a depth of 13 inches; and if all fell as rain it would cover the earth to the depth of 13 inches. The average fall of rain in the United Kingdom is about 34 inches; but in the western and hilly counties it is 48 or 50 inches. The average rain in London for 40 years, between 1777 and 1817, was 20·686 inches; at Paris in 15 years, was 18·649; at Glasgow in 17 years, was 21·033; at Manchester in 33 years, was 36·104; at Kendal in 1830, was 58·03. At Edmonton in 1831, the highest thermometer was 82°, and lowest 10°; barometer 80·5 and 28·9; rain 26·8; winds 232 days westerly, 8 north, 6 south. At Cheltenham, 1831, thermometer highest 77·5, lowest 25; barometer 30·26 to 28·52; rain 34·6; winds 166 days westerly, 36 north, and 55 south. Evaporation is everywhere as the surface of water, and as the temperature. There would be no interval between the solid and vaporous states but for the pressure of the atmosphere. All liquidity is, therefore, the effect of atmospheric reaction; and this is overcome when the force of the atomic motion of heat exceeds the compressive of 15 pounds to the square inch. It appears, therefore, to be the direct tendency of the motion called heat to disperse the atoms of a body; and vapour, steam, or gas is a conflict between the atoms of the body and those of the atmosphere. Hence it is that water fills the receiver of the air-pump with steam, and that it boils at such low temperature in elevations where the barometer falls considerably. Atmospheric air, at the freezing temperature, contains from a 200th to 160th of its weight of water, and double at every 22d or 27th degree. At 52°, it contains a 100th; at 74°, a 50th; and at 98°, a 25th. Hence, as cooled, it deposits the excess; and this is the dew of clear and calm nights. The earth is more heated by the solar rays than the air; and by night the

earth parts with more heat than the air, so as to become lower than the air. In light substances in contact with the earth, it is often from 15° to 20°. Hence 10 grains of wool, on a grass plot, in a night, gave 16 grains of dew,—9 on a gravel walk,—and 8 on mould. Hoar-frost is frozen dew. Grass is often but 30° when the air is 39°, and hence early freezing.

"The disputes," says the writer in the 10th volume of the Journal of Agriculture, "which have arisen regarding the merits of different cultivated grasses, have partly arisen from forgetting that a grass, valuable on account of its produce in one part of Britain, may, in another part, and consequently under a different climate, be found less profitable; and further, the power of becoming acclimated may be different in different species or varieties. 'The distribution of the cultivated grasses,' says Schouw, 'is determined not merely by climate, but depends on the civilization, industry, and traffic of the people, and often on historical events.' The truth of these remarks cannot be denied, but the first (climate, viz.) places impassable boundaries to the influence of the others. The same author remarks, 'The grains which extend furthest north in Europe, are barley and oats. These which, in the milder climates, are not used for bread, afford to the inhabitants of the northern parts of Norway and Sweden, and of a part of Siberia and Scotland, their chief vegetable nourishment.' In Norway, at Attengard, near N. lat. 70°, barley succeeds sometimes in the valleys, the snow line there is 3,600 feet; in N. lat. 65°, oats ripen. In Sweden, early barley reaches almost to the boundaries of the pine woods in N. lat. 69°, where the sun never sinks below the horizon from the latter part of May to the end of July. Oats, to the north of N. lat. 66°, very seldom ripen; the snow line here is 4,800 feet. 'In the course of the month of May,' remarks Dr. Richardson, 'ground was prepared at Cumberland House, and, toward the end of it, barley sown, to be reaped again in August, after an interval of about 90 days, whose mean temperature may be stated at 67°·8 Fahr. This place borders on the isothermal line of 32° F. According to Humboldt, barley, to be cultivated to advantage, requires, during 90 days, a temperature of from 47°·3 F. to 48°·2 F. Although the mean annual temperature of any place may be far below that at which seeds can germinate, still grain will come to maturity if the mean of the vegetating season reach a certain degree. Oats seldom ripen farther north than lat. 66°, the annual mean temperature being 33° F., that of the summer being 57°·8 F., while barley reaches to N. lat. 69°, where the annual mean is only 27° F., that of the summer being 54°·8. Professor Playfair proposed to date the vegetating season from 20th March to 20th October, and supposed that it is on the nature of that season that the quantity of the crop principally depends. He assumed 40° F. to be the lowest temperature at which corn will vegetate, and considered 56° F. as the mean temperature of a good vegetating season. The limit at which corn will not ripen he stated to be about 48° F. In the following table Professor Playfair's method has been adopted; and by the vegetating season is meant the period from 20th March to 20th October in each year. The fiars prices are assumed as fair criteria of the productiveness of the seasons, and are placed in comparison with the mean temperature of each year, the mean temperature of the vegetating season, and the total fall of rain. The fiars are those of Aberdeenshire as given in the Aberdeen almanack.

Years.	Mean of veg. season.	Annual mean temperature.	Excess of veg. season above 40°.	Rain in inches.	Oatmeal per boll.
					s. d.
1829	50°·94	46°·62	10°·94	28°·66	13 6
1830	51 ·24	46 ·81	11 ·24	30 ·60	16 8
1831	53 ·49	48 ·14	13 ·49	29 ·16	14 10
1832	51 ·98	47 ·83	11 ·98	21 ·07	12 0
1833	52 ·05	47 ·13	12 ·05	22 ·04	11 10
1834	53 ·22	49 ·18	13 ·22	12 ·28	14 6
1835	51 ·50	46 ·96	11 ·50	14 ·94	13 6
1836	50 ·92	46 ·14	10 ·92	24 ·69	18 0
1837	48 ·67	45 ·35	8 ·67	20 ·29	15 6
1838	48 ·58	44 ·25	8 ·58	34 ·40	21 6

Annual mean temperature at Aberdeen, from observations during the last sixteen years, = 47°·22.

"Professor Playfair says, 'Whether the quantity of the crop may be expected to be proportional to the excess of the mean temperature of the vegetating season, above 40° F., may deserve to be more accurately considered. There is every reason, however, to think that the variations of the crop, at least corn, will be greater than in proportion to the variations of temperature. By doubling the deficiency of the heat, we do a great deal more than double the deficiency of the crop, so that the latter varies in a higher ratio than the former. The limit at which corn will not ripen may perhaps be stated at 48°.' A writer in the Aberdeen Journal of January 18th, 1837, remarks, 'I have observed that if May, June, and July had an average of 54°·5 per diem, grain would fill and ripen notwithstanding an autumn as wet as that of 1829. In that year grain did ripen, while in the present year (1836) the average heat for the three months being 43°·29 F. only, the staple crops (barley and oats) in this district (Huntly) have ripened so imperfectly as in most cases to be unfit for seed, and deficient in weight compared with any crop since 1821.' In making such comparisons, it would be necessary to take into account the comparative temperatures of shorter periods of time. It is of importance to note the daily range of temperature, as this forms a prominent feature in the nature of the seasons. The study of the relation between climate and the productiveness of the different crops, is deserving of much attention. The difference between the nature of any two

seasons may be such as to be worthy of being considered equal to a difference of several degrees of latitude; hence the importance of selecting early or hardy kinds of grain, by which means the consequences of an unfavourable vegetating season may be much modified. The distribution of rain throughout the vegetating season constitutes also a very important feature of its character. Frequent rain, although not very copious, will be less favourable to vegetation than a greater quantity falling at longer intervals, provided it is not so overpowering as to cause lodging of the crops. Other circumstances might be mentioned as worthy of notice; the number of clear and of cloudy days, and the state of the atmosphere in respect to the vapour contained in it,—the lowness or highness of the dew point."

The maintaining of a preternatural temperature by artificial means, ranging from those of mere special tropical shelter to those of the highest requisite fire or steam heat, constitutes the grand difference between the art of gardening and the art of farming, and comprises all the kinds and varieties of what is technically called forcing, and deals more or less with all exotic plants which will not perform the offices required from them, of growing, or flowering, or fruiting, in the open ground of the climate or situation in which they are cultivated. "Now in what may be termed the higher department of forcing, there are, perhaps, fewer objectionable points than in the lower scale—where the plants are not kept in pots, and are consequently liable to great discrepancy between their terrestrial and atmospheric temperatures. Much has been written on the latter; and in practice it has been found best to approximate it as nearly as possible to that climate in which the given species of exotic plants naturally acquires the highest perfection. Beyond this, nothing need or can be advanced; but, with regard to what may be termed terrestrial temperature, something useful may be stated. The vine, for instance, as regards temperature, may be, and often is, so situated as to have its shoots in the climate of Syria, whilst at the same time its roots are in that of Britain. Such being the case, there need be less surprise at the ill success which occasionally accompanies its cultivation, than at the reputed inexplicable causes of bad setting, shriveling, and shanking of the grapes. The mean temperature of the soil, or that portion of the earth extending to several feet below its surface, is nearly the same as the mean temperature of the incumbent atmosphere. The soil of England, so far as the generality of roots penetrate, may therefore be estimated at about 50° Fahr. for the average. In Armenia and Syria (which may be reckoned the native region of the vine, for there, since the remotest accounts of history, it has felt itself at home,) the mean temperature of the soil will not be below 60°; and in the growing season its temperature will, doubtless, be above 70°, corresponding with the temperature of the atmosphere which is imitated in the vineries of Britain, but forming a great discrepancy with the temperature of the soil of this country. But, although this will be allowed to be bad, still the worst of the evil remains to be noticed. The above is only a medium case of general occurrence; and, although some may not be so widely different as 10° in the action of temperature on root and branch, yet there are, in all probability, a greater number of cases in which the difference is considerably increased, from various causes powerfully tending to lower the temperature of the border. In order to illustrate some of the causes which have this tendency, let us make an experiment wherein the agencies bear close analogy to what actually occurs. Let a box, water-tight, be nearly filled with loose mould or peat, or sand, or even the composition of a vine border; let this be tolerably dry, in order to increase its capacity for water cooled to the temperature of 50°; then saturated with snow water a little above the freezing point. This process, with the aid of a frosty night, will bring the contents of the box below 40°, and is supposed to take place in the winter or early part of spring. If the box be 3 feet deep, the sun's rays will not affect it far below the surface, since water is not easily heated from above; and, besides, the heat through the day will, at that season, be greatly counteracted by the cold at night. As the season advances, rain may be expected of a temperature above 60°; and this, under some circumstances, would produce a very considerable effect. Unfortunately, however, the box was made water-tight; and its contents, being completely saturated with nearly gelid water, cold, and heavy, and mechanically immovable by the descending warmer and lighter fluid, the latter must recede by the surface in quest of an unoccupied lower level, after producing only a slight effect on the surface of the contents of the box. The analogy between this and a badly drained outside vine border is so obvious that it need not be traced; similarity might, indeed, be substituted for analogy. Nor is it necessary to point out the injurious consequences that must accrue to the forcing vine. He that is not sufficiently impressed with this, has only to imagine his feet to be plunged in the one temperature, and his body in the other,—the bare idea of such will make him shudder. Let us now, with the same box, and similar materials, endeavour to produce a different result; commencing by piercing the bottom, and making a complete drainage; and, further, keeping the contents as dry as possible, and neither exposing them to the sleety shower, nor placing them exterior to the front of the vinery, where it would receive an overshot of snow from the slippery roof; but letting the surface be snugly covered, or thatched from all such drenching, till genial showers of the temperature of 60° or more begin

to fall. The latter may find it below 50°, but it is not likely to be much below. If it should be thus low, the water of the above warmth would percolate speedily from top to bottom, and communicate its heat during its progressive descent. The soil being dry, a portion of the water would be held by capillary attraction among the particles of the former in the first instance; superabundance to this would be carried off by the drainage at the bottom, making room for a fresh supply of water, imparting a farther elevation of temperature, till the whole became ultimately on a par with the rain, or very nearly so. This process might be greatly accelerated by stirring the surface, or inverting it, when well heated by the sun's rays, so as to turn up a fresh portion to their influence. A considerable heat might be worked in by this means, even to the depth of the upper roots of the plants, and farther than that penetrated by the rain; but, the presence of the latter being necessary in other respects, it becomes a useful and appropriate conveyer of heat to a greater depth among the roots than could be accomplished in the open ground otherwise than by its soft insinuation. It is hoped that these remarks will be the means of directing attention to the necessity of an approximation of terrestrial and atmospheric temperature as regards the cultivation of exotics, and particularly that of the vine; and also to the use of water as a medium by which an increase of terrestrial heat is speedily communicated, when the former is properly applied, that is, when it is of a higher temperature than the substances with which it is brought in contact; and to the negative injurious consequences which follow its application at a low temperature."

TEMPLETONIA. A small genus of ornamental, red-flowered, evergreen, Australian shrubs, of the genista division of the leguminous order. Two species, the retuse-leaved and the glaucous, both about two feet high, and blooming in spring and the early part of summer, have been introduced to the greenhouses of Britain; and they love a soil of sandy peat, and are propagated from cuttings.

TENACITY OF METALS. Brick and stone are from their brittle nature never thrown into a state of tension, or employed for supporting pendant loads; therefore their properties in this respect have not been estimated or examined; but the materials usually resorted to for this purpose, are bars of metal and chains, cylindrical or prismatic pieces of timber, ropes, and leather or raw hide; and the following tables show the power of those substances most commonly met with and used to support loads, the measure of their cohesion being the number of pounds avoirdupois, which are just sufficient to tear asunder a rod or bundle of one inch square. From this it will be easy to compute the strength corresponding to any other dimensions.

Metals.		lbs.
Gold, cast, varies between		20,000 to 24,000
Silver, cast,	do.	40,000 to 43,000
Copper, cast,	Japan	19,500
	Barbary	22,000
	Hungary	31,000
	Anglesea	34,000
	Sweden	37,000
Cast Iron varies between		42,000 to 59,000
Bar Iron	ordinary	68,000
	good	75,000
	best Swedish and Russian	84,000
Steel bar	soft	120,000
	tempered straw colour	150,000
Tin, cast,	Malacca	3,100
	Banca	3,600
	block	3,800
	English block	5,200
	Do. grain	6,500
Lead cast		860
Regulus of Antimony		1,000
Zinc		2,600
Bismuth		2,900

Unfortunately these numbers do not accord with those of Mr. Rennie, who observes, "that the metals were held by nippers made of wrought iron, with their ends adapted to receive the bars, which, by being tapered at both extremities, and increasing in diameter from the actual section, and the jaws of the nippers being confined by a hoof, confined both. The bars, which were 6 inches long and ¼ inch square, were thus fairly and firmly grasped." The following are a few of the experiments that were tried 30th of April, 1817.

	lbs. avoir.
¼ inch bar of Cast Iron, cast horizontally, broke with	1,166
" Cast Iron, cast vertically, "	1,218
" Cast Steel, previously tilted, "	8,391
" Blister Steel reduced by the hammer	8,322
" Shear Steel do. do.	7,977
" Swedish Iron do. do.	4,504
" English Iron do. do.	3,492
" Hard Gun Metal (mean of 2 trials)	2,273
" Wrought Copper reduced by hammer	2,112
" Cast Copper do. do.	1,192
" Fine Yellow Brass do. do.	1,123
" Cast Tin do. do.	296
" Cast Lead do. do.	114

As all these experiments were made on ¼ inch square bars, sixteen of which laid in close contact with each other, would constitute a square inch, it may be inferred that multiplying any of the numbers above given, would produce the amount of strain that would break a bar an inch square; but it is found in practice, that a number of small bars thus laid together, will bear a greater proportion of load than a single bar equal to the sum of all their areas. This anomaly is believed to proceed from the greater perfection with which small bars may be wrought and prepared than large ones, as all metals are improved in their strength by hammering or wire-drawing; so the effect of hammering sixteen small bars separately, will add more to their strength, than hammering on a large bar equal to the sum of their areas. Metals can only be improved in their strength by hammering or wire-drawing, in consequence of these operations

forcing their constituent particles into a closer state of aggregation; and this can easily be done in small bars, because from their want of reaction, they yield to every blow of the hammer, and its effect is transmitted through their whole substance; while the reaction of a large and heavy bar opposes this effect, and the condensation is more confined to the surface. A number of small bars acting simultaneously, are, therefore, found to produce more strength than one large bar equal in size to their sum. It likewise explains why a faggoted bar of iron should be stronger than one that has not undergone the operation.—*Millington.*

TENANT. A person who holds tenements or lands or both, during a limited period, on consideration of rendering stipulated services or paying a stipulated rent to the proprietor. See the articles Rent, Agreement, Lease, and Land (Property in). A tenant at will holds during the pleasure of the lesser; a tenant from year to year either holds during strictly one year, or holds during an undeterminate period on consideration of an annual rent; and a tenant for a fixed period of years holds during the time specified in express agreement or in lease.

TENANT RIGHT. The right of a tenant to all the productive results of any improvements which he makes upon his land, or to a fairly valued compensation for such of them as are unexhausted at the expiration of his term of occupancy. This right is to the full as obvious as that of lease-tenure, which we have contended for in the article Lease, and rests on substantially the same principles, and works out nearly the same effects; and were any such practices between landlord and tenant as those which we have advocated in that article to become universally approved and adopted, it would be so amply superseded as to find not an inch of scope for a separate existence; but, on the supposition that many landlords may still load all leases with oppressive conditions, that many others may pertinaciously maintain the system of very short lease-tenure or of absolute tenancy-at-will, and that neither class may be likely to adopt more correct views of what is due to themselves, to their tenants, and to the whole community, under any less gentle influence than that of an express and stringent act of parliament, the question of tenant-right gravely proposes itself as a fit and urgent subject of legislation. We do not see any need for our taking a side on this question; and we think we have said enough on all the grand principles of land-occupancy in the articles Land (Property in), Lease, and Rent; yet we shall present our readers with a brief abstract of the most telling part of a recent Prize Essay on the subject from the pen of Henry Corbet, secretary of the London Farmer's Club:—

"By the aid of frequent discussion at public meetings, and repeated notices from the press, many of the more intelligent farmers and active landlords will, no doubt, give the subject of tenant-right a place in their agreements; while, on the other hand, those who most require that impetus it carries with it would be left to keep on just as they so long have been. Tenant-right will never, or, at least, cannot for many years, come into general use from the efforts of such agency as this alone. Self-contented, unaspiring, stand-still tenants will pass it over again and again, precisely as they do now; and short-sighted owners, that, in the words of a noble lord who lately stood forward to represent them, 'would rather keep to their old tenants and old ways than put up with new at double the rent,' will 'pooh! pooh!' its progress, as they are doing at present. Look, for example, as to the gradual spreading of tenant-right, at the petition of the Lincolnshire landlords against the passing of any enactment for insuring it—unintentionally the best argument that was, perhaps, ever offered for making such an Act. Say the Lincolnshire landlords—'We have tenant-right already; we have long practised and profited to the full by its advantages. What then can be the use of enforcing by law what we do voluntarily?' Exactly so. The action of tenant-right has brought the bogs and fens of Lincoln from the worst to be the best cultivated land in the kingdom, and doubled and trebled its value to both landlord and tenant. This has been proved and known for many years, and has of course proceeded to this very natural consequence. Neighbours first, and their neighbours again, *ad infinitum*, have gradually adopted so excellent a plan, until at length the whole country has learnt the secret of the men of Lincoln, and brought its acres to vie in produce with those of that once favoured district. Is it so? and is any further inducement for following your example so entirely superfluous? Or rather does not the tenant-right part (only) of the county of Lincoln stand out at this moment like an oasis from the north, south, east, and west territory by which it is surrounded? This famous protest—and it will be worth while to proceed with it a little further—is framed in defiance of the first principle of legislation. Laws, be it remembered, are required not to compel the just, but to restrain the unjust,—in vulgar phrase, 'for rogues, not honest men.' Now a good and just landlord that does his duty voluntarily, and gives his tenant full recompense for all he may not have reaped, needs no enactment to induce him to this. Such a law could in no way affect him, for he does and has done all so provided for without it. The object is to make others follow his example, and ensure their doing that by law that many would hesitate, from ignorance, prejudice, or a worse motive, to do of their own free will. Thus, the answer to all who join in with the Lincolnshire landlords is plain enough: if, as you say, you have the tenant-right secured to you by the custom of your own district, our new Act will to you be as nothing, either good or bad; all we want is to extend that custom to others. So, to the argument of the tenant, who, happy in this custom, or with a full confidence in the honour of that high family who always have and always will, he is sure, do him justice, let us reply that our only desire is to see other landlords like his. In the strength of his own position such a measure may sound superfluous enough, but it may yet be much required elsewhere. We have, however, heard some go further than this, and in the gratitude of their hearts declare that the very fact of legalizing tenant-right would be the greatest insult that could be offered to the good landlord; because, as they say, it would convey a doubt as to his continuing to show that justice which had never been doubted before. In direct contradiction to this, we affirm it is the highest compliment you could pay him; it is the stamped approval of the course he has

pursued, drawing the eyes of all others upon him, and forcing them to imitate his well-doing. 'Imitation,' says the Spectator, 'is, after all, the sincerest flattery:' though here, we think, it pays homage of a more sterling character.

"But it may be demurred, before we proceed to frame new enactments entirely after this said example, it might be as well to see if there are any laws now professing to regulate the transactions between landlord and tenant. There are many; though, as far as any good or just consideration is concerned, they are almost all absolute nullities. To any one who could read over the Acts of this kind still remaining on the statute book, the necessity for some further addition to, or revision in them, would be strikingly apparent. As the state of society improves, as men gradually advance from comparative barbarism to civilization, it may be fairly assumed that corresponding alteration in those laws which affect their relative positions would accompany and facilitate such improvement. With agriculture, however, this has not been the case. Acts framed and passed when landlords were allowed the power of tyrants, and tenants were contented with the condition of slaves, are yet in existence, if not in actual use. So absurd and detrimental, indeed, would any application of them be, that landlord and tenant join together to prevent all possible reference to such relics of a by-gone age. The two unite, in the absence of any thing better, to make a law fit for the times they live in; and yet what is the consequence of this being done by individuals, instead of being provided for by government, and so brought into general practice? Why, such a substitute becomes, in effect, nearly as injurious to the real advance of agriculture as the old law in all its one-sided power of might would be. The agent whereby the new one is attained, and the old one avoided, is the long, elaborate, technical agreement, stipulating and providing for everything; and this said long elaborate agreement is declared by all practical men to be the greatest clog and impediment the tenant farmer can be burdened with. It confuses and frightens him, stays him from attempting anything not laid down exactly by rule and rote in it, and haunts him with provisions and penalties prepared by lawyers who know little of farming, to be acted upon by farmers who know as little of law. The agreement for the farmer should be made to suit the nature of the man, and be as plain, straight-forward, and as little verbose as possible. In fact, a long 'comprehensive' one, like a long rambling sentence, too often misses the point of that it aims at, and in striving to teach too much, finishes by defining little or nothing. To be truly useful and impartial, justice must speak the language of her people, and avoid in every way following in the steps of those senators of old who gave out their edicts rather to excite the awe than suit the understanding of those whose actions they were intended to influence. To extend, then, and establish that justice involved in the rights of tenants—to let all alike participate in their advantages—can be accomplished by legislative enactment alone. But then comes the difficulty of making this enactment practicable, or of carrying out the principle into general use. The ways of letting differ so in different counties, we are told—what is indispensable in agreement here, is never mentioned there; in a word, so many and curious are the customs, that, instead of one Act only to embrace all the country, you must draw out a different one for every different district. Now we maintain that the legal recognition of tenant-right can scarcely be made in terms too general. Let it be admitted on the understanding that it shall, in effect, embrace every part of the country; and let the Act be as simple and as short as possible. Let it contain a definition of the principle, 'a right of claim to compensation for unexhausted improvement,' and we shall be satisfied. Customs may vary, and times for going in and out not always the same; but still the main point may be made equally applicable everywhere. A man that has purchased and put on manures in Devonshire, ought surely to have his case as fairly considered and adjusted as if he had been living in Lincolnshire. A man who has drained or marled land in the south will do as much good to that land, and so should reap as certain a return, as if it had been in the north. The rate of labour perhaps, or the price of the material applied, may be higher or lower in one place than another; but this, after all, is nothing but what may be well met in the valuation. By valuation, then, would we make tenant-right feasible; by valuation would we accomplish for the agriculturist what has so long been done by the same means in every other kind of business, and than which nothing can be more straightforward or simple.

"The items which the tenant should be empowered to charge upon might be put under two heads,—as improvement which it is the proper business of the farmer to proceed with, and that which had better come direct from the landlord,—'Landlord's Improvements' and 'Tenant's Improvements.' The temporary and durable will be at once admitted as fit employment for the capital and labour of the latter, embodying as they do the great requisites for good and profitable farming; while the permanent—the building, road-making, fencing, and so on—should, we think, be done by the owner, or, at any rate, only undertaken by the holder on some special agreement. We have heard it advanced with much reason, that to give the merely temporary cultivator of the land a power of making and charging for any new buildings or fences he may choose to erect, would be imbuing him with too great, and the owner with too little, command over, and interest in the soil. Such a clause too, we fear, gets beyond that extreme simplicity with which we would have the measure carried out, and, indeed, can scarcely be brought within the accepted definition of tenant-right, viz., compensation for unexhausted improvement. Now the term unexhausted applies clearly to, in different degrees, both the temporary and the durable,—the means taken for 'amending the soil;' while the unexhausted good left at the end of a term in a barn or a stable is so entirely a different feature as to warrant, we should say, a different way of meeting it. In this view of the matter we are in a great measure supported by the opinion of the Tenant Right Committee of the London Farmers' Club, appointed to go through the different clauses of Mr. Pusey's bill, who, in their report, thus express themselves on this point:—'Do recommend that all items respecting buildings, roads, and fences, be left out of this bill, and that a clause be added, or a supplementary bill be prepared, to afford tenant-farmers those privileges in the removal of buildings erected by themselves, which manufacturers and tradesmen now enjoy—the landlord having, in the first place, the option of taking all, or any, by valuation.' This, in fact, is but further evidence of the tenant-farmer being still, as the law stands, regarded as little more than a serf, or, at least, a steward,—obtaining, may be, some reward for his care and industry, but with no recognised claim for what he may have spent, on his services being dispensed with. If a man erects a building for any possible purpose but that of agriculture, he may, on quitting, pull it down again and take it with him. The law allows it to be his: and if the landlord will not buy it, the tenant may sell the material to another, or carry it away for use elsewhere. While it provides for and protects one, the law oppresses his neighbour, by suffering a measure so out of all date yet to exist,—an enactment the action of which, if

ever through ignorance or carelessness permitted to come into force, can only be used to serve the ends of injustice. Once more we say, let the farmer be placed in the same condition, have the same acknowledged rights as other men who live by their labour —or, with the Tenant Right Committee. 'let him have those privileges, in the removal of buildings erected by himself, manufacturers and tradesmen now enjoy.'

"The natural advantage likely to accrue from the establishment of tenant-right becomes so thoroughly and prominently a part of the whole question, that a few words addressed to that particular point may not be out of place in concluding. The paramount duty of the government—the basis of the national prosperity—is the well-doing of the people; and that people at this very moment are suffering, more or less, from two great evils of over-population—a want of employment and a want of food. In direct antithesis to this, the producible land of the kingdom is cultivated as if there was actually scarcity of labour. The natural question that arises here is, how comes it that one evil is not made to destroy the other, by the application of the labour to the land? Simply because there is a hesitation as to embarking capital to bring them together; and yet, in the face of this hesitation, it is generally allowed that nothing will pay a better interest than money laid out in the improvement of the soil. The people want employment; the land wants more cultivation. The use of capital refused; and yet no use of capital known to pay better. Paradoxes explained and removed by the one simple remedy and right—security. Give but that, and you will make the island, as it should be, mainly dependant on its own resources for food, and its people for support. The national advantage must increase from such an increase of labour profitably employed, for money is really but the representative of labour so directed; and consequently the more labour profitably employed, the more wealthy must the country become. This is a remedy, moreover, that might be applied without sacrifice or expense to any one. The people would experience no revulsion to their ordinary habits, the government no embarrassment from the effects of it. It is only making general an act of justice that has proved strikingly advantageous wheresoever it has yet been administered."

TENCH,—scientifically *Cyprinus Tinca*. A British fresh-water fish, of the carp family of abdominal malacopterygians. It loves still waters, and chiefly frequents weedy and tangled places overshaded with rushes or brushwood; and it has prime qualities of flesh when found in rivers, but is far more abundant in pits, pools, and lakes. It begins to spawn in June, and continues to spawn in some situations till September; and is in its best season for the angler from the latter part of autumn till May. It lives long out of water; and may safely be removed in dry straw to a considerable distance. Its flesh is both wholesome and delicious food.—The tench seldom exceeds 4 or 5 pounds in weight. The body is proportionally thicker than long; the scales are very small and covered with slime; the eyes are large, and of a golden colour, and have red irides; the mouth is leathery, and sometimes has a small bark at each corner; the back and the dorsal and ventral fins have a dusky colour; the head, the sides, and the belly have a greenish hue, most beautifully mixed with golden tints; and the tail is quite even at the end and very broad.

TENDON. The white shining extremity of a muscle. The flexor tendon of the horse's leg is sometimes though rarely broken; and its ruptured ends should be stitched together and supported by a bandage.

TENDRILS. The organs by which climbing and twining plants attach themselves to shrubs, trees, poles, walls, or other objects for support. A tendril is generally a filiform and spiral process; and issues variously from stem, branch, petiole, or leaf; and is always much stronger than a shoot or twig of its own size. In most cases, in order to take secure hold, it simply twists itself into circumvolutions; but, in a few, it terminates in a flat, fleshy, adhering sole.

TENEMENT. A house, yard, or other fixed structural property held by a tenant.

TENORIA. A genus of ornamental, evergreen, exotic shrubs, of the umbelliferous order. Eight species, varying in height from 8 or 9 inches to 5 or 6 feet, all carrying herbaceous-coloured flowers, most blooming in the early part of autumn, and all propagable from cuttings, have been introduced to British gardens from Southern Africa and the shores of the Mediterranean. Two of the best known are noticed in the article Hare's-Ear.

TENESMUS. A continuous and vain effort of the horse or of any other animal to void dung. It arises from irritation in the rectum, and is generally cured by emollient or anodyne glysters.

TENURE. The kind of right or the set of legal circumstances by which fixed property is held either in perpetuity or during a limited period. See the articles Lease and Land (Property in).

TEPHRITIS. See Leaf-Miners.

TEPHROSIA. A genus of ornamental exotic plants, of the lotus division of the leguminous order. About 30 species have been introduced to British gardens, principally from India, America, and Southern Africa; and about 50 more are known. About one half of the introduced species, consisting principally of tender, evergreen undershrubs, with either purple, pink, or reddish flowers, are somewhat closely akin, in their botanical character, to the goat's-rue genus; and all these—as also all the others, most of which likewise are evergreen shrubs, but some of them taller—have pinnate leaves, with a terminating odd leaflet. Most love a soil of peaty loam, and are propagated from cuttings. The fish-poison species, *T. toxicaria*, an evergreen shrub of about 3 feet high, from South America, carrying pale red flowers in terminal panicled racemes, is cultivated in its native country.

TERAMNUS. A small genus of ornamental, tropical, red-flowered, twining plants, of the kidney-bean division of the leguminous order. Two species, the twining and the hooked, both about 10 feet high, and propagable from cuttings, have

been introduced to British collections from Jamaica.

TEREBINTHACEÆ. A natural order of ligneous, calyciflorous plants, represented by the turpentine-tree or *Pistacia terebinthus*. See the article PISTACHIA-TREE. This order is somewhat nearly allied to the Leguminosæ; yet has very indeterminate botanical characters, and consists wholly of trees and shrubs, with balsamiferous resin, alternate exstipulate leaves, and inconspicuous flowers. Their resin is very abundant, and resides chiefly in the bark and leaves, and is the principal character by which the limits of the order are determined. About 60 hothouse species, nearly 70 greenhouse species, and between 20 and 30 hardy species, occur in British collections; and they are distributed into 7 tribes or suborders, and into nearly 30 genera. The types of the tribes are plants of the genera anacardium, rhus, bursera, connarus, spondias, cneorum, and amyris. Many of the species, in spite of the inconspicuousness of their flowers, and for the sake chiefly of the beauty of their foliage, rank high as ornamental plants; a considerable number, such as the pistachia and the cachew, the mango and the spondias, are valuable for their fruits; many are serviceable, in ways widely different from one another, to medicine and the arts; and some, such as *Amyris toxifera*, and several species of sumach, possess very acrid and poisonous properties. The balsam of Mecca is obtained from *Balsamodendron gileadensis;* the balm of Acouchi, from *Icica heterophylla*; Venetian turpentine, from *Pistacia terebinthus*; various kinds of gum, from *Icica leptophylla*, *Amyris elemifera*, *Pistacia lentiscus*, and *Pistacia atlantica;* most fragrant incense, from *Boswellia serrata*, *Amyris balsamifera*, *Canarium commune*, and several species of *Icica;* excellent and valuable varnishes, from *Icica guianensis* and several species of *Rhus;* and medicinal preparations or economical substances of several kinds, from other species of *Rhus*.

TERMINALIA. A genus of ornamental, tropical, evergreen, greenish-flowered trees, of the combretum order. Nearly twenty species, chiefly about 20 feet in ordinary natural height, and all loving a soil of peaty loam, and propagable from cuttings, have been introduced to the hothouse botanical collections of Britain; and about a dozen more are known. One division of the genus has drupes compressed at the margins, and winged or much attenuated,—and another has dry or baccate drupes of ovate or sub-compressed form, with round and angulately sulcate putamen; and two species belonging respectively to the two divisions, and serving as a fair specimen of the whole genus, are described in the articles CATAPPAN and CHEBULA.

TERNSTRŒMIA. A genus of ornamental, tropical, thalamiflorous, ligneous plants, constituting the type of the natural order Ternstrœmiaceæ. This order is nearly allied to the camellias and the tea-plants, and exhibits a strict identity with them in general appearance, and consists wholly of trees and shrubs, with beautiful, white, yellowish, or reddish flowers. About a dozen hothouse species, 4 or 5 greenhouse species, and 6 or 7 hardy species, occur in British collections, and are distributed among 11 or 12 genera. Four species of the genus ternstrœmia, all evergreen shrubs of about 6 feet in height, blooming in the latter part of summer and early part of autumn, and propagable from cuttings, have been introduced to Britain from the West Indies and the tropical parts of South America; and nearly a dozen other species are known.

TERRIER. See DOG.

TESTICLES. The two glandular bodies which are contained in the scrotum of a male animal. In all species, they are formed in the abdomen; and in many, as in birds, they always remain there; but in others, as in the young colt, they remain during only a short time after birth, and then gradually descend to the scrotum,—and they carry with them thither a covering or investiture from the peritoneum, and are ever afterwards clothed with it. In man, whose erect posture would occasion a descent of intestinal matter through any opening, all communication between the abdomen and the scrotum is perfectly closed,—but in the horse and other quadrupeds, whose horizontal posture prevents all risk of such descent, a communication between the two cavities remains constantly open; and in man, an unusual quantity of fluid is sometimes secreted between the testicle and its investiture, constituting the disease called hydrocele,—while in the horse this seldom happens. The operation of cutting out the testicles of the lower animals is noticed in the article CASTRATION.

TETANUS, or LOCKED JAW. This is one of the most appalling maladies with which the veterinarian has to deal. It attacks all the three chief species of farm animals; but is of far the greatest consequence in the horse; and a brief notice of it in the case of that animal may sufficiently illustrate it in the case also of cattle and sheep.

Though a disease of the nervous system, its effects are more particularly visible in the muscles,—and most of all in the voluntary muscles,—which are all seized with a spasm or rigidity, so that the animal can move no part but with pain and difficulty, while some parts are altogether immoveable. The approach of the disease is generally slow. The animal commonly first shows some rigidity about the neck in turning his head to one side, which, in the course of a day or two, so much increases that he cannot turn his head at all without carrying his body round too. The refusal of his food leads to an examination of the jaws; and they also are found rigid, or greatly limited in their dilatation, so that the mouth can be opened only to a certain

extent, or even hardly at all. The eye becomes the next object of attention: every time any thing frightens or annoys him, the animal throws up his head, and at the same instant the haw is seen passing over the eye; and this forms a very striking character of the malady. The limbs, now, should they not have already become attacked, likewise grow stiff, either rendering progression awkward and unnatural, or else almost impeding it altogether. Indeed, in violent cases, the fore and hind legs are stretched out underneath the body like the four legs of a stool or form; the back and loins become shrugged up from rigidity; the tail is elevated and tremulous; the ears erect; the nostrils expanded; and the countenance displays a degree of eagerness and anxiety which, once seen, it is hardly possible to mistake. In short, the poor suffering animal exhibits altogether a truly impressive and pitiable aspect, too characteristic of the hopeless condition he is in, to admit of any possibility of doubt or dispute concerning the nature of his relentless disease. Locked jaw may arise of its own accord, or at least without any apparent cause; or it may be, and most commonly is, the consequence of some local injury. We have many examples of its having been induced by nicking, and docking, and punctured wounds, particularly into joints, or the feet; and the curious circumstance is, that the disease generally makes its appearance after the local wound is healed up, and we conclude all is well.—We are much in the dark concerning what mode of treatment ought to be adopted for this disease; though it would appear, that of all the declared remedies none deserves to stand so high as opium. It behoves him, however, who sets about to treat a locked jaw, to remember that it is a malady which has but very rarely yielded to remedy, and that opium, like every thing else, has too often failed to give the slightest apparent relief. In the first instance, it is advisable to draw blood, especially if the horse should happen to be in full condition; and also to administer, as early as possible, a dose of croton oil or two ounces of purging mass, whose operation may be promoted by injections. As soon as the bowels have become freely opened, or even before, should the case prove anywise urgent, begin with the opium; if possible, administer half an ounce in ball twice a-day; but, should the jaws not admit of this being accomplished, an equivalent quantity of laudanum should be exhibited. Blisters also may be applied, or setons inserted, along the course of the spine, and upon the head. Some veterinarians advise rubbing the jaws and throat with stimulating liniments; and Gibson recommends continual rubbing of the head, neck, and cheeks, or wherever the stiffness may appear, until the horse is relieved. He also observes, that locked jaw sometimes proceeds from the irritation of botts in the stomach; in which case he directs half an ounce of calomel to be given at one dose. When the disease appears to depend on a wound in the foot, either from a prick in shoeing or stepping on a nail, the part should be laid open with a drawing knife, and the actual cautery applied. As long as the horse is capable of swallowing, wheat-flour gruel should be frequently given.

TETHERING. The confining of a grazing animal to small and precise limits of pasturage by means of a rope or of a light chain, fastened to a long iron pin, which has a swivel ring and is driven into the ground. This practice is advantageous for a very few animals on lawns which are ornamented with shrubs, and on rich grass fields which have insufficient fences, or on plots of luxuriant grass adjacent to unprotected arable crops, as it obliges the animals to make clean work of the herbage, and at the same time prevents them from injuring the neighbouring vegetation; but it is unprofitable either for a large number of animals on rich pastures, or for even the smallest number on poor ones, as it would require a far too frequent and troublesome change of tether to comport with economy; yet it prevails throughout almost all France, even on common farms, and is somewhat abundant in some of the most impoverished districts of Great Britain and Ireland.

TETRACERA. A genus of ornamental, tropical plants, of the dillenia family. Three species, the drinking, the twining, and the alder-leaved, all evergreen twiners of upwards of 10 feet in height, loving a soil of peaty loam and propagable from cuttings, have been introduced to British hothouses from Africa and South America; and about 20 more are known.

TETRADYNAMIA. See Botany.

TETRAGONIA. A genus of exotic plants, of the order Ficoideæ. Two annual species, one biennial, one herbaceous evergreen, and six evergreen undershrubs, all green-flowered, and most between 10 and 25 inches high, have been introduced to the greenhouse collections of Britain from the Cape of Good Hope, New Zealand, and Peru; and several more are known. Only one species possesses any particular interest; and that is noticed in the article New Zealand Spinach.

TETRAGONOLOBUS. A genus of ornamental, hardy, trailing, exotic plants, of the lotus division of the leguminous order. Three annual species, with respectively yellow, purple, and dark purple flowers, and two perennial species, with yellow flowers, have been introduced to Britain; and one of the former, *T. purpureus*, called by Linnæus *Lotus tetragonolobus*, and popularly the purple-winged pea, a native of Sicily, is cultivated by the Sicilians as an economical plant.

TETRAMERIUM. A genus of ornamental, tropical, ligneous plants, of the madder family. Two species, the panicled and the sweetest-scented, both evergreen white-flowered shrubs of

5 or 6 feet in height, have been introduced to the hothouse collections of Britain, from Guiana and the West Indies; and two other species are known. The two introduced species are near akin to the coffee-tree; and they love a soil of loamy peat, and are propagated from cuttings.

TETRANDRIA. See Botany.

TETRANTHERA. A genus of ornamental, evergreen, ligneous, greenish-flowered, exotic plants, of the laurel order. Eight or nine species, varying in height from 6 to 25 feet, have been introduced to the greenhouse and hothouse collections of Britain from Australia, Mexico, China, and India; and some more are known. Most of the introduced species love a soil of peaty loam; and all are propagable from cuttings. The three-nerved and the rusty are two of the smallest, and need only greenhouse protection; and the glaucescent and Cervantes's are two of the tallest, and require the heat of the hothouse.

TETRAPELTIS. A recently discovered genus of ornamental tropical plants, of the vandea division of the orchidaceous order. The sweet-scented species, *T. fragrans*, is a white-flowered epiphyte, introduced 12 or 14 years ago to Britain from Nepaul. The name tetrapeltis signifies 'four-bucklered,' and alludes to the form of the pollen-masses.

TETRAPOGON. A curious, hardy, annual grass, of the chloris tribe. It constitutes a genus of itself, and is specifically called the villous. It is a native of Barbary, and was introduced to Britain about 30 years ago; and it has a height of about a foot, and blooms in July and August.

TETRAPTERIS. A genus of ornamental, tropical, ligneous plants, of the barbadoes cherry family. Two species, the box-leaved and the orange-leaved, both yellow-flowered, evergreen shrubs of about 6 feet in height, have been introduced to British gardens from Cayenne and the West Indies; and they love a soil of peaty loam, and are propagated from cuttings. Several other species are known.

TETRATHECA. A genus of handsome, Australian, evergreen, thalamiflorous undershrubs, constituting the main part of the small natural order Tremandreæ or Tremandraceæ. They have a peculiarly neat appearance, and exhibit considerable resemblance to heaths. Seven or eight species, principally about 12 or 15 inches in height, mostly with purple-coloured flowers, and all blooming in July and August, have been introduced to the greenhouses of Britain; and they love a soil of sandy peat, and are propagated from seeds. The hairy species, *T. hirsuta*, one of the most recently introduced, may serve as a sufficient specimen of the whole. It is a light, open, branching bush, characterised by neatness and simple elegance; and is all over hairy. Its leaves are alternate, small, oblong-ovate, and hairy, and give the branches a clothing of foliage; and its flowers are produced from the axils of the leaves, and stand on footstalks projecting at least an inch from among the foliage, and have each five nearly oval petals, spread out in a star-like form, and are at first of a bright pink colour, but afterwards assume a darker hue. It requires to be grown in a well-drained pot, and secured against damp in winter.

TEUCRIUM. See Germander.

THALIA. A small genus of ornamental, blue-flowered, exotic, herbaceous plants, of the Indian-shot family. The white species, *T. dealbata*, is a greenhouse aquatic of 4 or 5 feet in height, introduced to Britain about 58 years ago from Carolina, and blooming in July and August; and the jointed species, *T. geniculata*, is a hothouse, terrestrial, herbaceous evergreen of about 2 or 3 feet in height, introduced about 25 years ago from the West Indies, and blooming in August and September.

THALICTRUM. See Meadow Rue.

THAPSIA. See Deadly Carrot.

THATCH. The culms of cereal grass or the slender stems or fronds of other plants laid on the top of ricks, buildings, and other structures to protect them from wet. The thatching of ricks, both small and great, is noticed in the article Stack. The thatching of houses, sheds, and other edifices may be done in any one of various ways, and with any one of widely different materials, to suit convenience, appearance, durability, and other circumstances. Fern thatch, if obtained between the middle of September and the middle of October, and properly prepared and skilfully laid on, will last in a sunny exposure during 18 or 20 years, and will seldom cost more than about one shilling per square yard. Heath of a slender and pliant nature, obtained from an open situation, properly prepared, and laid on in horizontal layers or from end to end of the roof, and, in an elevated and airy place, or in any one which is free from undue closeness and humidity of atmosphere, will last between 20 and 30 years. Reeds form a very valuable and long-enduring thatch, and are sometimes cheaper in the end than any other material; but they cost comparatively very high at first, and are also thought by some persons to be too stubborn for common purposes. The thrashed straw of wheat, with the ears on it, is the thatch most generally in use throughout the plains and valleys of Britain; and, when well laid, forms at once a very neat, a quite secure, and a sufficiently or tolerably durable covering for most structures to which it is applied. Unthrashed wheat straw, without the ears, and provincially called reed, is the favourite thatch in the counties of Devon, Dorset, and Somerset, and possesses eminent advantages above thrashed straw, which ought to recommend it into use in all parts of the kingdom. It lasts nearly as long again as common straw, and does not offer the temptation arising from the grains of imperfectly thrashed corn, which induces mice and birds to infest the building, and to make holes in the thatch. The mode of

preparing it is simply to take a sheaf of wheat, and to place it in a press, made of two pieces of timber 10 feet long, and put on a stool, and to have women to lay hold of the ears and draw them out and cut them off, and then to bind up the sheaf for thatch. A covering with this straw is not only neat but elegant, while one with the thrashed straw is ragged and slovenly; and it has, in many instances, been preferred to all other coverings for cottages ornées in consequence of its picturesque effect. Rye straw is also neater, more durable, and less liable to be filled with water than common thrashed wheat-straw, in consequence of its having a solid stem. The art of fixing thatch on houses is similar to that of fixing it on ricks, but is much nicer and more elaborate, and requires thicker layers, stronger fastenings, and split willows or some similar materials instead of straw-ropes, and is properly the work of a separate class of artificers, who qualify for it by a regular apprenticeship.

THEA. See Tea.

THEAVE. An ewe of the first year.

THEEZAN TEA. See Buckthorn.

THELYGONUM. See Dog's Cabbage.

THELYMITRA. A genus of curious, tuberous-rooted, herbaceous, Australian plants, of the orchis order. Eight or nine species, principally blue-flowered, and all about a foot high, blooming from April till June, loving a soil of loamy peat, and propagable by division of the root, have been introduced to the greenhouses of Britain. See the article Orchis.

THEOBROMA. See Cacao.

THEOPHRASTA. A small genus of ornamental, exotic, ligneous plants, of the dog's-bane family. Jussieu's species, *T. Jussiœi*, is a white-flowered, evergreen shrub, of about 3 feet in height, introduced 30 years ago to the greenhouses of Britain from Central America. It requires a soil of rich mould, and is propagated from seeds.

THERMOMETER. An instrument for measuring heat, founded on the principle that the expansions of matter are proportional to the augmentations of temperature. With regard to aeriform bodies, this principle is probably well founded; and hence our common thermometers may be rendered just by reducing their indications to those of an air thermometer. Solids, and still more liquids, expand unequally, by equal increments of heat, or intervals of temperature. With regard to water, alcohol and oils, this inequality is so considerable as to occasion their rejection for purposes of exact thermometry. But mercury approaches more to solids than ordinary liquids in its rate of expansion, and hence, as well as from its remaining liquid through a long range of temperature, is justly preferred to the above substances for thermometric purposes. A common thermometer, therefore, is merely a vessel in which very minute expansions of mercury may be rendered perceptible, and, by certain rules of graduation, be compared with expansions made on the same liquid by other observers. The first condition is fulfilled by connecting a narrow glass tube with a bulb of considerable capacity filled with mercury. As this fluid metal expands one sixty-third by being heated in glass vessels, from the melting point of ice to the boiling point of water, if ten inches of the tube have a capacity equal to one sixty-third of that of the bulb, it is evident that, should the liquid stand at the beginning of the tube at 32°, it will rise up and occupy ten inches of it at 212°. Hence, if the tube be uniform in its calibre, and the above space be divided into equal parts by an attached scale, then we shall have a centigrade or Fahrenheit's thermometer, according as the divisions are 100 or 180 in number. Such are the general principles of the construction of thermometers.

The tubes drawn at glass-houses, for making thermometers, are all more or less irregular in the bore. Hence, if equal apparent expansions of the included mercury be taken to represent equal thermometric intervals, these equal expansions will occupy unequal spaces in an irregular tube. The attached scale should, therefore, correspond exactly to these tubular inequalities; or, if the scale be uniform in its divisions, we must be certain that the tube is absolutely uniform in its calibre. The first step in the formation of this instrument, therefore, is to graduate the tube into spaces of equal capacity. A small caoutchouc bag, with a stop-cock and nozzle, capable of admitting the end of the glass tube when it is wrapped round with a few folds of tissue paper, must be provided, as also pure mercury, and a sensible balance. Having expelled a little air from the bag, we dip the end of the attached glass tube into the mercury, and by the elastic expansion of the caoutchouc, we cause a small portion of the liquid to rise into the bore. We then shut the stop-cock, place the tube in a horizontal direction, and remove it from the bag. The column of mercury should not exceed half an inch in length. By gently inclining the tube, and tapping it with the finger, we bring the mercury to about a couple of inches from the end where we mean to make the bulb, and, with a file or diamond, mark there the initial line of the scale. The slip of ivory, brass, or paper, destined to receive the graduations, being laid on a table, we apply the tube to it so that the bottom of the column of mercury coincides with its lower edge. With a fine point, we then mark on the scale the other extremity of the mercurial column. Inclining the tube gently, and tapping it, we cause the liquid to flow along till its lower end is placed where the upper previously stood. We apply the tube to the scale, taking care to make its initial line correspond to the edge as before. A new point for measuring equal capacity is now obtained. We thus pro-

ceed till the requisite length be graduated, and we then weigh the mercury with minute precision. The bulb is next formed at the enameller's blow-pipe, in the usual way. One of a cylindrical or conical shape is preferable to a sphere, both for strength and sensibility. We now ascertain and note down its weight. A tubular coil of paper is to be tied to the mouth of the tube, rising in a funnel-form an inch or two above it. Into this we pour recently boiled mercury, and, applying the gentle heat of a lamp to the bulb, we expel a portion of the air. On allowing the bulb to cool, a portion of the mercury will descend into it, corresponding to the quantity of air previously expelled. The bulb is now to be heated over the lamp till the included mercury boil briskly for some time. On removing it, the quicksilver will descend from the paper funnel, and completely fill the bulb and stem. Should any portion of air appear, the process of heating or boiling must be repeated, with the precaution of keeping a column of superincumbent mercury in the paper funnel. When the temperature of the bulb has sunk to nearly that of boiling water, it may be immersed in ice-water. The funnel and its mercury are then to be removed, and the bulb is to be plunged into boiling water. About one sixty-third of the mercury will now be expelled. On cooling the instrument again in melting ice, the zero point of the centigrade scale, corresponding to 32° of Fahrenheit, will be indicated by the top of the mercurial column. This point must be noted with a scratch on the glass, or else by a mark on the prepared scale. We then weigh the whole. We have now sufficient data for completing the graduation of the instrument from one fixed point; and, in hot climates, and other situations, where ice, for example, cannot be conveniently procured, this facility of forming an exact thermometer is important. We know the weight of the whole included mercury, and that of each *gradus* of the stem. And, as from 32° to 212° Fahr., or from 0° to 100° cent., corresponds to a mercurial expansion in glass of one sixty-third, we can easily compute how many of our graduating spaces are contained in the range of temperature between freezing and boiling water. Thus supposing the mercurial contents to be 378 grains, one sixty-third of that quantity, or six grains, correspond to 180 of Fahrenheit's degrees. Now, if the initial measuring column were 0·6 of a grain, then ten of these spaces would comprehend the range between freezing and boiling water. Hence, if we know the boiling point, we can set off the freezing point; or, from the temperature of the living body, 98° Fahr., we can set off both the freezing and boiling points of water. In the present case, we must divide each space on our prepared scale into eighteen equal parts, which would constitute degrees of Fahrenheit; or into ten equal parts, which would constitute centigrade degrees; or into eight, which would form Réaumur's degrees. When we have ice and boiling water at hand, however, we may dispense with the weighing processes. By plunging the instrument into melting ice, and then into boiling water, we find how many of our initial spaces on the stem correspond to that interval of temperature, and we subdivide them accordingly. If the tube be very unequal, we must accommodate even our subdivisions to its irregularities, for which purpose the eye is a sufficient guide.

Thermometers are used for two different purposes, each of which requires peculiar adaptation. Those employed in meteorology, or for indicating atmospherical temperature, are wholly plunged in the fluid; and hence the stem and the bulb are equally affected by the calorific energy. But when the chemist wishes to ascertain the temperature of corrosive liquids, or bland liquids highly heated, he can immerse merely the bulb and the naked part of the stem under the scale. The portion of the tube corresponding to the scale is not influenced by the heat, as in the former case; and hence one sixty-third part of the mercury, which, at 32° Fahr., was acted on, has, at 212°, escaped from its influence. Hence a meteorological and a chemical thermometer ought to be graduated under the peculiar conditions in which they are afterwards to be used. The former should have its stem surrounded with the steam of boiling water, while its bulb is immersed an inch or two beneath the surface of that liquid, the barometer having at the time an altitude of thirty inches. A thermometer for chemical experiment should have its boiling point determined by immersion only of the bulb, and the naked portion of its stem below the scale, in boiling water. The water, of course, must be pure; and it ought to be contained in a metallic vessel. Before sealing up the end of the tube, we should draw it into a capillary point, and heat the bulb till the mercury occupy the whole of the stem. A touch of the blow-pipe flame on the capillary glass will instantly close it, and exclude the air from re-entering when the bulb becomes cool. If this has been skilfully executed, the column of mercury will move rapidly from one end of the tube to the other when it is inverted with a jerk. An ivory scale is the handsomest, but the most expensive. Those used in Paris consist of a narrow slip of paper enclosed in a glass tube, which is attached in a parallel direction to the thermometer stem. It is soldered to it above by the lamp, and hooked to it below by a ring of glass.

Comparative Scales of Thermometers.—A fertile cause of error in estimating and comparing the statements of temperature, is the very different manner in which they are made by scientific men of different nations. Wherever the English language prevails, the graduation of Fahrenheit is generally preferred. By the German authors Réaumur is used; and the French have, within

a few years, decided to adopt that of Celsius, a Swedish philosopher, calling it *thermomètre centigrade*. The Russians still use the graduation of De Lisle. The two remarkable temperatures of the boiling and the freezing of water are thus expressed by the several thermometers mentioned:

	Fahr.	Centig.	Réaum.	De Lisle.
Boiling point, .	212°	100°	80°	0°
Freezing point, .	32	0	0	150

So that the number of degrees of each, included between these two points in each, is 180° Fahr., 100° centig., 80° Réaum., 150° De Lisle; and of course 9° Fahr. = 5° centig. = 4° Réaum. = $7\frac{1}{2}$° De Lisle. Fahrenheit's is, therefore, the smallest degree, and Réaumur's the largest. The 0° is called the *zero:* all degrees below this are called *minus*, and are prefixed by a dash, thus –20°. In the Réaumur and centigrade scales, the degrees above zero are also called *plus*, and marked thus, +20°, to prevent one kind being mistaken for another.

Rules for changing the degrees of any one of the scales into equivalent degrees of another:

Fahrenheit into Réaumur.—Each degree of Fahrenheit is equal to four-ninths of one of Réaumur. As Réaumur, however, reckons his degrees from the freezing point, and Fahrenheit 32° below this point, we must, when the number of Fahrenheit's degrees to be reduced indicates a temperature above the freezing point, first deduct thirty-two, and then multiply the remainder by four, and divide the product by nine. The quotient is the corresponding number of degrees on Réaumur's scale. If the temperature indicated was less than the freezing point, we must also be careful to take the actual number of degrees, reckoning from the freezing point. Thus four degrees above Fahrenheit's zero is twenty eight below his freezing point; and this is the number to be reduced to Réaumur's scale.

Réaumur into Fahrenheit.—Each degree of Réaumur is equal to $2\frac{1}{9}$ of one of Fahrenheit. Multiply the given number of degrees of Réaumur by nine, and divide the product by four. If the degrees of Réaumur were minus, the quotient must be deducted from thirty-two, and the remainder will be the equivalent degrees of Fahrenheit. If the given degrees were not minus, the quotient must be added to thirty-two degrees, and the sum will be the equivalent sought.

Fahrenheit into Centigrade.—Each degree of Fahrenheit is equal to five ninths of one of the centigrade. Proceed as in the case of Fahrenheit into Réaumur, multiplying, however, by five and dividing by nine.

Centigrade into Fahrenheit.—Proceed as in Réaumur into Fahrenheit, multiplying by nine and dividing by five.

Réaumur into Centigrade.—Each degree of Réaumur is equal to $1\frac{1}{4}$ of the centigrade. Multiply the given number of degrees of Réaumur by five, and divide the product by four; the quotient will be the equivalent number of degrees on the centigrade scale.

Centigrade into Réaumur.—Each degree of the centigrade is equal to $\frac{4}{5}$ of Réaumur. Multiply the given number of degrees of the centigrade by four, and divide the product by five; the quotient will be the equivalent number of degrees on Réaumur's scale. Extensive tables of the correspondence of these thermometrical scales, and of some of the most remarkable temperatures, may be found in the *Treatise on the Thermometer and Pyrometer*, in the Library of Useful Knowledge.

THERMOPSIS. A genus of ornamental, hardy, yellow-flowered, perennial-rooted herbs, of the sophora division of the leguminous order. Four species, of from 12 to 25 inches high, blooming in June and July, loving a rich soil, and propagable by radical division, have been introduced to Britain from the temperate regions of Asia and America. The name thermopsis signifies "lupine-like," and is descriptive.

THESIUM. See Bastard Toadflax.

THESPESIA. A small genus of ornamental, tropical, evergreen trees, of the mallow tribe. The poplar-leaved species, *Thespesia populuca*, called by Linnæus *Hibiscus populneus*, is a native of India, and was introduced about 80 years ago to the botanical collections of Britain. It has naturally a height of about 30 or 35 feet; and it loves a soil of peaty loam, and may be propagated from cuttings. Its flowers are white; its timber is used by the Hindoos for making wheels, bandy-bodies, and similar articles; its bark is employed in powder as a medicinal alterative, and in strong decoction as a wash for certain cutaneous affections; and the juice of the fruit is employed in the same way as the decoction of the bark.—The great-flowered species, *Thespesia grandiflora*, was introduced to Britain from Porto Rico in 1827; and has scarlet flowers, and is naturally of similar height to the poplar-leaved species.—The name thespesia signifies 'divine,' and was suggested by the practice of planting the trees around the churches of their native regions.

THICKET. A dense growth of trees or shrubs, such as cannot be easily penetrated by men or cattle.

THICK-WIND. A chronically morbid state of the lungs of a horse, resulting from certain varieties and terminating influences of pneumonia. It consists in the conversion of part of the lungs into a substance similar to the liver, and involves a constant abridgment of the proper function of the lungs, and occasions continual shortness and difficulty of breathing, and is indicated by comparative shortness and violence of both inspiration and expiration, and by the emission of a peculiar sound which, when once heard, is ever afterwards easily recognised. An experienced veterinary surgeon, by means of auscultation, can estimate pretty closely the degree of it, and tell in how far it will diminish the horse's working power, or permanently diminish his value; but he cannot do any thing of a surgical or of an actively medicinal nature either to cure or to palliate it. The best treatment for preventing disastrous consequences from the disease, and at the same time for gradually and most effectually lessening it, is to feed the animal on such nutritious food that a comparatively small bulk of it will satisfy him,—to allow him ample rest after every meal, before beginning

to work him,—and to train him carefully and regularly up to the full stretch of his breathing powers, but not a jot beyond them, either in daily work or in daily exercise, so that he may acquire an increase of them by the force of habit. —The constitutional breathing action which the heavy draught horse has of a distinct and contrasted nature from that of the racer or the hunter is sometimes, but improperly, called thick-wind. See the articles HORSE, BROKEN-WIND, and PNEUMONIA.

THILL-HORSE, or THILLER. The last horse of a team yoked in line,—the horse that goes between the thills or shafts.

THINNING. See PLANTATION.

THISTLE. A large group of composite-flowered, herbaceous plants, comprising many of the most common and troublesome weeds of agriculture. The strictly proper thistles constitute the genus Carduus, and form the type of the suborder Carduaceæ. This suborder is very extensive, and comprises four divisions or tribes,—first, the true Carduaceæ, containing native and imported plants of at least 30 genera,—next, the Vernoniaceæ, containing plants of about 20 genera,—next, the Gnaphalieæ, containing plants of about 15 genera,—and next, the Echinopsideæ, containing plants of about 13 or 14 genera. A large proportion of the true Carduaceæ either are popularly called thistles or may very readily be mistaken for them,—particularly all the species of the old genus Cnicus, and of the modern genera Carduus and Cirsium, and many or all of the species belonging to the genera described in our articles THISTLE (PLUME), CARLINE THISTLE, COTTON-THISTLE, LEUZEA, SAW-WORT, RHAPONTICA, SILYBUM, and CENTAUREA. Some plants also are popularly called thistles which do not belong to any division of the Carduaceous suborder,—particularly those of the cichoraceous genus noticed in our article SOW-THISTLE.

The strictly true thistle genus, Carduus, comprises at present 3 indigenous species, about 40 introduced exotic species, and about 60 unintroduced known exotic species; and it formerly comprised some other species, both indigenous and exotic, which are now assigned to the genera cirsium, serratula, and silybum. A few of the species in Britain have sessile or petiolated leaves, but the vast majority have decurrent leaves; some have an aggregate inflorescence, but a greater number have a subsolitary inflorescence; two or three have red or white flowers, and all the rest have purple flowers; a few have a height of only from 6 to 20 inches, and a few are so high as 5 or 6 feet, but most have a height of from 2 to 4 feet; about a dozen are annuals, and the rest are, in pretty equal proportions, biennials and perennials. The musk or nodding species, *Carduus nutans*, is an annual indigen of the grass lands of Britain, about 2 feet high, with decurrent leaves and purple subsolitary flowers, blooming in July and August. The acanthus-like species, *Carduus acanthoides*, is an annual indigen of the waste grounds of Britain, about 2 feet high, with decurrent leaves and purple subsolitary flowers, blooming from June till August. The slender-flowered species, *Carduus tenuiflorus*, is an annual indigen of the hedge-banks and similar situations of Britain, about 2 feet high, with decurrent leaves and purple aggregate flowers, blooming from June till August.

The principal annual plants of the popular thistle group which infest the farm-lands of Britain are the three true thistles which we have just noticed, the common or potherb sow thistle, *Sonchus oleraceus*, and the centaury star-thistle, *Centaurea calcitrapa;* the principal biennial ones are the welted, curled, or Virgin Mary's thistle, *Silybum marianum*, the common carline-thistle, *Carlina vulgaris*, the marsh plume-thistle, *Cirsium palustre*, the bull-thistle, spear-thistle, or common plume-thistle, *Cirsium lanceolatum*, and the common cotton thistle, *Onopordum acanthium;* and the principal perennial ones are the corn-thistle, way-thistle, or common field plume-thistle, *Cirsium arvense*, the various-leaved plume-thistle, *Cirsium heterophyllum*, the meadow plume-thistle, *Cirsium pratense*, the common or corn-field sow-thistle, *Sonchus arvensis*, and the dwarf thistle or stemless plume-thistle, *Cirsium acaule*.

Thistles are an exceedingly troublesome and destructive class of weeds; and they demand the sedulous care, not only of individual farmers, but of whole communities, for keeping them down and exterminating them. They tend to occupy an aggregately large area of cultivated land to the exclusion of useful plants; they appropriate a large amount of the nutrimental principles within the soil, to the starving of the crop or the herbage amidst which they grow; they present so fierce an obstacle to the reapers of corn as to tempt them to grip and handle loosely the culms, and in consequence to leave a large amount of waste upon the field; they, in many instances, maintain so pertinacious a hold upon spots where they have taken root as to be very difficult of extermination; they, in all instances, so facilely and multitudinously scatter their winged downy seeds far and wide upon the wind that one free growth of them in a single nook of a district, or on a part of only one neglected road-side or one slovenly-managed farm would speedily propagate them over an area of many square miles; and wherever a rich lea soil, capable of producing the most luxuriant crops of grain, is newly broken up, they so invariably and sometimes so profusely arise as to have given occasion to the adage for a blind man's choosing land, "Tie me to a thistle." A law exists in France obliging all farmers to free their lands from thistles at the proper season, and empowering any one to sue a neighbour who neglects this work, or to employ other people to do it at his expense; and a similar law in Britain, and in all other countries, would be of great economical value.

Thistles are vastly less troublesome on grass lands than on arable lands; and when any of the most common kinds are once eradicated thence, and kept from growing and seeding along the hedges and ditches, they seldom give any further annoyance. Their seeds do not readily vegetate unless on any soil which is not loose; and are so much and greedily sought after by little birds, that they rarely lie long enough to germinate, especially in the early part of winter, except when wholly or partially covered with earth. The common carline thistle, the centaury star thistle, and the stemless plume-thistle infest pastures with sandy or calcareous soils oftener than loamy or clayey grass lands; and, whenever they greatly prevail, they cannot be effectually subdued by any operation short of breaking up the land and subjecting it to a course of crops. The marsh plume-thistle, the various-leaved plume-thistle, and the meadow-plume thistle prevail most in loamy and clayey soils; and must be dealt with in the manner of other perennial thistles. All annual and biennial thistles, on whatever kind of land they grow, may be readily subdued by either carefully pulling all up before they run to seed, or frequently mowing them over close to the surface, and rolling.

The removal of thistles from arable land under drilled crops, is more or less fully effected, in ordinary circumstances, by the operation of the horse-hoe; but the weeding of them out of broadcast crops, can only be done by manual operation, and is much more difficult. The common kinds may be destroyed by means of weeding pincers, or by pulling them up between the finger and the thumb from loose soil, or by cutting them over in the bleeding season, and applying a little salt to the stumps of the cut stems; but some of the perennial kinds, in consequence of their living roots or rootlets remaining in the ground, and throwing out new shoots or stems every year, can, in many instances, be effectually or even tolerably subdued only by deep ploughing and frequent harrowings, or by subjecting the land to a complete summer fallow, or by laying it down to grass. Either the stemless plume-thistle or any similar species, which infests sainfoin, lucern, or any other crop of a protecting and overshadowing character, may be reduced by the application of a little salt to the crown of each plant. The application of salt, in fact, has sometimes been proclaimed as a panacea against all thistles; and, whenever tried, the salt should be laid on the centre of the thistle, with the finger and the thumb, to the amount of about a teaspoonful to each plant, at some time before the thistle has attained a large size; and, in the course of a day or two, the plant may turn black, and in the course of nine or ten days will die down to the root. The best time for eradicating perennial thistles on any piece of ground which they have long infested is when they are in full bloom and beginning to form their seed.

THISTLE (Carline). See Carline Thistle.

THISTLE (Cotton). See Cotton Thistle.

THISTLE (Plume). A large group of carduaceous plants, of the true thistle tribe. It was formerly identified with the old genus *Cnicus*,—a genus which modern botanists have broken up, and distributed among the genera cirsium, leuzea, rhapontica, silybum, and serratula; and it may now be regarded as not far from being identified with the genus Cirsium, to which the major portion of the cnicuses have been assigned. See the article Cirsium. All the plume thistles are prickly herbaceous plants, differing from the true thistles principally in their down being not merely rough but evidently feathery; and some have decurrent leaves, and red or purple subsolitary flowers,—others, decurrent leaves, and pink or purple aggregate flowers,—others, sessile leaves, and purple subsolitary flowers,—others, sessile leaves, and purple aggregate flowers,—and others, sessile leaves, and white or yellow flowers,—though no species of either of the last two of these subdivisions grows wild in Britain.

The common or spear plume thistle, *Cirsium lanceolatum*, is a biennial indigen of the roadsides, banks, and waste grounds of most parts of Britain. Its stem is 3 or 4 feet high; its leaves are decurrent; and its flowers are purple and subsolitary, and bloom from June till September.—The marsh plume thistle, *Cirsium palustre*, is a biennial indigen of the moist meadows, the moist pastures, and moist spots of the road-sides of Britain. Its stem is from 3 to 6 feet high; its leaves are decurrent; and its flowers are purple and aggregate, and bloom in July and August.—The meadow or English plume thistle, *Cirsium pratense* or *Cirsium anglicum*, is a perennial-rooted indigen of low meadows and pastures, particularly among trees, in various parts of Britain. Its root is fibrous; its stem is 3 or 4 feet high; its leaves are sessile; and its flowers are purple and subsolitary, and bloom in June.—The tuberous plume thistle, *Cirsium tuberosum*, is a perennial-rooted indigen of the woods of some parts of England. Its stem is 3 or 4 feet high; its leaves are sessile; and its flowers are purple and subsolitary, and bloom from August till October.—The wool-bearing or wool-headed plume thistle, *Cirsium eriophorum*, is a biennial indigen of the road-sides and waste mountainous grounds of the calcareous districts of Britain. Its stem is 4 or 5 feet high, and, together with its foliage, gives the plant a massive and conspicuous appearance; its leaves are sessile; and its flowers are purple and subsolitary, and bloom in July and August.—The various-leaved or melancholy plume thistle, *Cirsium heterophyllum*, is a perennial-rooted indigen of the moist mountainous pastures of Scotland and the north of England. Its stem is about 2 feet high; its leaves are sessile; and its flowers are purple and subsolitary, and bloom in July and August.—The corn or way or creeping plume thistle, *Cirsium arvense*,

is a perennial-rooted indigen of the road-sides and cultivated fields of Britain; and is very troublesome, and not a little difficult of extirpation. Its root is fleshy and very vivacious, and both creeps far and strikes deep, so as to resist every slight or ordinary effort to destroy it; its stem is from 2 to 4 feet high; its leaves are sessile; and its flowers are purple and subsolitary, and bloom in July.—The dwarf or stemless plume thistle, *Cirsium acaule*, is a perennial-rooted indigen of the cultivated lands of Britain, particularly of grass lands which have a light soil. Its root is woody and runs deep into the ground; its stem is the mere root-crown, or rather is entirely a-wanting; its leaves are large, bright green, and sessile, and spread close to the ground in a circle of nearly a foot in diameter, and choke all grasses and other herbage within their range; and its flowers are purple and subsolitary, and bloom in July and August.—Forster's plume thistle, or the branching bog plume thistle, *Cirsium Forsteri*, is a perennial-rooted indigen of the bogs and moist woodlands of some parts of England. Its root is tapering; its stem is 3 or 4 feet high; and its flowers have a crimson colour, and bloom in July and August.

THISTLE (Star). See Star Thistle.

THISTLE (Way). See Saw-wort and Thistle (Plume).

THLASPI. See Shepherd's Purse.

THOMASIA. A genus of ornamental, evergreen, Australian shrubs, of the byttneria family. Six or seven species, some apetalous, others with white, pink, or purple flowers, most about 3 feet high, and all loving a soil of sandy peat, and propagable from cuttings, have been introduced to the gardens of Britain. The large stipuled species, *T. stipulacea*, introduced in 1844, may be taken as a specimen of the whole. Its leaves stand on long footstalks, and are heart-shaped, hairy, and deeply notched; and its flowers come out in little racemose clusters opposite the leaves, and are large and lean all one way, and have a pink colour with a shady suffusion of light purple, and bloom in profusion toward autumn. Most of the other species, however, bloom from April till July.

THORAX. The chest-cavity of an animal's body, containing the lungs, the heart, and part of the windpipe and the gullet. It is divided into two parts by a duplicature of the pleura, and separated from the abdomen by the diaphragm.

THORN. Any ligneous plant which possesses a spinous armature,—but particularly the hawthorn and other indigenous, economical, spinous shrubs and small trees. See the articles Hawthorn and Spine.

THORN. A spinous process, whether the true spine of such plants as thistles, or the woody, spear-like armature of the hawthorn and other powerfully prickly shrubs. A thorn, as distinguished from a spine, grows only on ligneous plants, and has a woody nature, and may be regarded as an abortive, indurated, sharply-pointed bud. When a thorn pierces a horse, and breaks, and remains in the wound, it ought with all possible speed to be drawn out with small pincers, and, if necessary, first loosened and made easily extractable by means of an incision; and, if it cannot be removed, or if it be neglected till inflammation set in, poultices should be applied to encourage suppuration.

THORN-APPLE, — botanically *Datura*. A genus of ornamental, hardy, annual plants, of the nightshade family. Nearly a dozen species occur in British collections,—principally natives of America, China, and Northern Africa; and most are about 2 or 3 feet high, and have white flowers, and love a soil of rich mould, and bloom from June or July till September, and possess very active properties of a poisonous or dangerously medicinal nature; but two, the Tatula and the proud, have respectively blue and purple flowers,—and the first of these, and also the Stramonium and the fierce, thrive best in a light soil.

Stramonium or the common thorn-apple, *Daturo stramonium*, is the best known species, and has a place in the pharmacopœias, and may serve as a sufficient specimen of the whole genus. It is a native of America, and was introduced to Britain, by way of Constantinople, toward the close of the 16th century, and is now naturalized, so as to grow in a wild state among the rubbish of waste grounds, of dunghills, of road-sides, and of the vicinity of gardens. Its stem is cylindrical, branching, dichotomous above, spreading, leafy, and 2 or 3 feet high; its leaves spring on long cylindrical footstalks from the forks of the stem, and are large, triangularly ovate, unequal at the base, sinuated on the margin, dark green above, and pale below; its flowers stand on short erect footstalks, and are solitary, axillary, and large, and have a white funnel-shaped plaited corolla, and bloom from July till September; and its fruit are large, fleshy, somewhat ovate capsules, armed with sharp, awl-shaped spines, and containing a great number of compressed kidney-shaped seeds. The whole plant emits a fetid, narcotic, sickening odour; and the leaves, the capsule, and the seeds possess very fierce narcotic, stimulating, and poisonous properties. Stramonium, when eaten by mistake, has produced fatal effects; and when cautiously administered, in the way of potion, has produced bewilderment and stupefaction, and aided some of the most horrid designs of wicked men; and when smoked in the manner of tobacco, relieves the paroxysms of spasmodic asthma; and when intelligently used by physicians, according to well-tested pharmaceutical formula, in the various forms of extract, powder, tincture, ointment, and cataplasm, has been found to act beneficially in a number of widely different diseases. But it is eminently one of the class of terrible drugs

which no quack or unscientific or inexperienced person should dare to touch. One analyst found, in 178 parts of it, 58 of gummy extractive, 6 of extractive, 64 of chlorophylle, 15 of albumen, 12 of resin, and 23 of phosphate of lime and magnesia; and other analysts have found in the seeds a peculiar, narcotic, alkaline principle, called daturine, which exists in combination with malic acid, and which, when separated, crystallizes with difficulty, and is nearly insoluble in water, and forms neutral salts with most acids.

THOROUGH-DRAINING. See Draining.

THOROUGH-PIN. A bursal enlargement in the horse's hock, similar in nature to bog-spavin. When the tumour is pressed on one side, the fluid within is forced to the opposite side; and hence the fantastic name thorough-pin. When the disease causes lameness, it may require to be attacked by blistering or firing; but it seldom does this, and may in general be best let alone.

THOROUGH-WAX. The round-leaved hare's-ear. See the article Hare's-Ear.

THORTER-ILL. See Louping-Ill.

THRASHING. The operation or process of separating the seed from the stems of corn, pulse, oleiferous seed plants, and all similar crops. The place on which the Hebrews, the Egyptians, the Romans, and other ancient nations adjacent to the Mediterranean performed this operation, was not the floor of a barn or of any other building or enclosure, but an open circular area in an elevated part of a field or on the tabular summit of a mount or hillock, levelled and beaten firm, and commonly about 30 or 40 paces in diameter. The thrashing-floor of Araunah the Jebusite—incomparably more remarkable in its associations than all other recorded thrashing-floors whatever, and most gloriously signalized as part of the site on which Solomon afterwards built the Temple of the true Deity—seems to have been simply a large esplanade on the broad and flattened top of Mount Moriah. All thrashing-floors required to slope slightly from the centre to the circumference, and to have a very smooth and perfectly firm surface; and they were variously formed by levelling rock, by laying pavement, by compacting clay, or by depositing some sort of mortary compound, according to the nature of the situation, and character of the soil. "Make a thrashing-floor in this manner," says Cato in reference to any ordinary kind of ground: "dig the soil, and sprinkle it with amurca, and allow the amurca to be imbibed; then pulverize every bit of hard earth, and smoothen all the surface, and work it hard with beaters; and afterwards sprinkle it again with amurca, and allow it to dry; and if the thrashing-floor be thus made, ants will not hurt it, nor will herbs grow upon it." Other Roman writers recommended that the thrashing-floor should be so situated as to be easily observable by the landlord or by the steward,—that it should be on high ground and much exposed to the wind, in order that it might naturally be maintained sweet and clean,—that it should be distant from gardens, orchards, vineyards, and groves, so as not to become defouled by their fallen foliage,—that it should be raised in the middle, in order that rain might readily drain away from it,—and that it should have a circular outline, so as both to economize space and to afford the most convenient scope for thrashing action by either oxen or implements. Some thrashing-floors, in wet climates, had roof-coverings, to shelter them from rain; others, in hot climates, had awning-coverings, to shelter them from the heat of sunshine; and others, in pastoral districts, were encompassed with a stone wall, to protect them from trespass by animals. In some instances, the workmen reposed on the awning-sheltered thrashing-floors during the heat of the day; and in not a few—as in that of Boaz, recorded in the book of Ruth—the proprietors or others slept on them during the night. The several varieties of thrashing-floor now used in the barns of Britain are noticed in the article Barn.

The operation of thrashing, in warm and dry countries, where seeds have a comparatively slight adherence to their envelopes, is much easier than in cold and wet countries, and requires a correspondingly facile class of appliances. In the earlier periods of the Hebrew commonwealth, a mere rod or cudgel seems to have been the ordinary thrashing implement, and perhaps the only one; but in the more advanced periods of that commonwealth, as well as among contemporary nations of the East, and among some later nations of Southern Europe, the treading of oxen and the action of several kinds of toothed and wheeled machines were used for most large crops or large quantities, and the rod or cudgel reserved only for small kinds of grain or for small quantities. One Jewish thrashing-implement, called baerkanim, is obscurely known, but seems to have been a square piece of wood, armed on the lower side with sharp stones; another, called morag, comprised four beams so joined as to form a square, and had three revolving cylinders set between the beams, and each furnished with three iron wheels, having teeth like those of a saw; and a third, called harootz, was formed like the second, except that the cylinders, instead of having iron saw-toothed wheels, were furnished with sharp pieces of iron, six inches long and three broad. The Jews, when obedient to the Divine law, "did not muzzle the ox that trod out the corn;" but the ancient Greeks, according to Ælian, besmeared the mouth of the poor animal with dung, in order to prevent it from eating. The Jews, so far as we know, may have used oxen both to tread out the corn by walking loosely over it, and to draw the heavy varieties of their thrashing implements; the ancient Greeks appear to have used chiefly the loose treading of oxen; and the ancient Romans, as well as the more polished of the nations who

were subject to them, used variously the flail, the loose treading of horses, the loose treading of oxen, and the draught-power of oxen in attachment to a machine which they called tribulum. "This machine," says Varro, "is made of a board rough with stones or iron, which, with a driver placed upon it, or a great weight, is drawn by yoked cattle to beat the grain from the ears; or it is made of a plank, with little rollers in place of teeth,—and this latter kind is called plostellum pœnicum."

At what period the flail was invented is not known. But it gradually superseded all the other methods throughout a large portion of the Roman empire; and was for many centuries the chief or only thrashing implement among most of the European nations; and continues still to maintain that place in very many of the small farms of Britain, and to be everywhere in request for the thrashing of small crops and small quantities. See the article FLAIL. The subject of modern thrashing machines will be discussed in the next article; and the comparative merits of these and of the flail, and also the details of labour throughout the modern processes of thrashing, are noticed in the article BARN-MANAGEMENT.

"In commencing the operation of thrashing with any large modern thrashing-machine, the power should be applied at first with caution. A great and rapid force of water, steam, or wind, at first, is apt to strain some weaker part of the machinery; and even if all the horses start strongly off at first, the course-wheel may be heard to creak. A full velocity of the mill should be produced before any corn is put in. In preparing the sheaves, the band should be loosened, and laid along the sheaf to which it belongs; but, as time is often limited to this operation of loosening the bands, many people who are careful prefer to throw them aside and thrash them by themselves afterwards; in which case, the corn knot is completely loosened out, and the thrashing is perfect. Less careful people, on the other hand, cut the band with a knife, and allow it to pass along sidewise with the sheaf, when the corn knots are frequently unthrashed, particularly when the straw is short. In feeding the mill, some dexterity is requisite. One sheaf at a time is quite sufficient for most mills, and a large sheaf is even too much. No more should be presented than what the mill can pass through without the least apparent retardation of its velocity. A velocity which permits the man who feeds to count the strokes of the scutchers of the drum is too slow; and it impresses one with the idea that the mill is fatigued, and is likely to be overcome. Then much of the corn will escape untouched. Oats with long straw in a dampish state is the most apt to produce this retarding effect, though the moving power of the mill be quite adequate to its task. Wheat with strong and long straw will produce a similar effect; but, with wheat, this effect often arises from a deficiency in the moving power. Damp oat-straw sometimes warps itself round the upper feeding roller; and in some mills, this warping is got rid of by reversing the motion of the feeding rollers, by means of a bayonet which operates on their pinions. Where this device is awanting, the warped straw must be cut away in pieces by a large knife, which should be kept at hand for the purpose. The sheaf should be spread evenly on the feeding-in board, for should any part of it be thicker than the rest, the upper feeding roller will be elevated by it, and the thinner parts will escape with the corn attached to it. To give the man full command of the sheaf, one only should be upon the table at a time, and that only replaced by another, when the former is removed by the man. This arrangement is very necessary for the performance of good work; but it is one which those who loosen the sheaves very readily neglect, because it causes them to be more attentive to the removal of the sheaf by the man who feeds in, and it prevents them throwing a large heap of sheaves upon the table, during the removal of which they got leave to rest or talk. Opportunity, however, for this neglect arises only at the outset of the thrashing process, when the sheaves are piled near the mill. Besides laying the sheaf even, the man who feeds should shake the straws loose in the sheaf, and draw them out thinner, that the drum may have access to every ear of corn. A screen should be placed between the man's face and the rake, to protect it from the grain, particularly wheat, which is thrown by the scutchers of the drum with inconceivable velocity against the rake; but the screen should be removable at the will of the man, that he may have an opportunity of seeing whether any of the straw is fastened on the teeth of the rake, and revolves round with it. In a fine season the grain is easily separated from the straw, and few or any unfilled grains occur in such a season. But in a cold and sunless season, the grains separate very reluctantly from the chaff. Indeed, in the case of wheat and oats, the grain and chaff often go together, and the awn from the barley is broken through the middle; and, in the case of all inferior or middle-rate or old-fashioned mills, nothing but repeated thrashings will completely separate the grain of wheat from the chaff. Nor will any kind or number of thrashings effectually break off the awn of barley; and to effect this purpose, a hummeller is attached to some thrashing machines." See the articles BARN-MANAGEMENT and HUMMELLER.

THRASHING MACHINES. The earliest recorded attempts to construct a modern thrashing machine, were made by the distinguished Jethro Tull; but they seem to have been somewhat crude, and they were very unsuccessful. The next attempt was made almost immediately after by Mr. Michael Menzies, brother to the

then sheriff-depute of East-Lothian; and, in consequence of its partial though brief success, is commonly mentioned as the germ of the whole system of thrashing machinery. Mr. Menzies' machine was patented in 1732, and declared by the Society of Improvers in Scotland to be likely "of great use to farmers, both in thrashing the grain clean from the straw and in saving a great deal of labour." It was driven by a water-wheel, and contained a series of flails, which were made to revolve upon a cylinder; but, owing perhaps to the velocity which was found requisite for the correct performance of the work, the flails were soon broken in pieces, and the whole machine became useless.

About the year 1758, a machine of a widely different construction, and of far more promising character, was invented by Mr. Michael Stirling, farmer in the parish of Dunblane, in Perthshire. This machine, somewhat similar to a flax-mill, had a water-wheel and perpendicular shaft or axle, into which were fixed four arms, enclosed in a cylinder about 3 feet high and 8½ feet in diameter. The shaft and its arms, within the cylinder, were driven with considerable velocity; the corn was presented by hand, and was let down through an opening in the top of the cylinder, and underwent smart scutching strokes from the arms, so as to undergo a separation of the straw from the ears or grain; and the straw passed outward through an opening in one side of the cylinder, while the ears fell down through an opening in the floor into a mechanism of rakes and fanners, and there underwent a final separation into grain and chaff. This machine was found to break off the ears of barley and wheat instead of clearing them of the grain, and proved to be tolerably suitable only for oats; yet it came into extensive use, and continued till quite a recent period to be used in some parts of Scotland, and driven either by water or by cattle.

In 1772, a machine was invented by Messrs. Alderton and Smart, two gentlemen in Northumberland, "by which the sheaves were carried round between an indented drum of six feet diameter, and a number of fluted rollers, which, pressing by means of springs against the fluted concave, rubbed out the corn from the ears." In 1785, a machine, denominated "a mill for separating grain from straw," and constructed on a similar principle to the coffee-mill, was patented by Mr. William Winlaw of Marylebone, but it was found, not only to thrash the corn, but to bruise and grind the grain. In the latter part of last century, some other machines were invented for thrashing corn in the way of rubbing; but all, as well as Winlaw's, more or less damaged the grain, and were in consequence discarded. In 1792, a machine was patented by Mr. Willoughby of Bedford in Nottinghamshire, constructed on a somewhat similar principle to the original one of Menzies, and comprising a series of loose or hinge-hung flails, which were kept in rapid play by means of a horse-wheel, and made to act upon a grated platform. In 1795, an invention was brought out by Mr. Jubb of Lewes for "passing the straw between two rapidly revolving beaters, under which it was held by two feeding-rollers, whence the corn fell into a winnowing-machine." About the year 1796, a machine was introduced to England, invented by Mr. James Wardropp of Ampthill in Virginia, and so formed as to be worked by two men. It was made with flails or elastic rods 12 feet in length, of which twelve were attached in series, each having a spring requiring a power of twenty pounds to raise it three feet high at the point. A wallower shaft, with catches or teeth, in its revolution successively lifted each flail in alternate movements, so that three of the flails were operated upon by the whole power, viz., twenty pounds, while three were two-thirds raised, three one-third raised, and three at rest; consequently, the whole weight to be overcome was 120 pounds. The flails beat upon a grating, to which the corn was introduced by hand. "In communications from M. D. Musigny to the Society of Arts," continues Mr. Ransome, from whose work on Agricultural Implements we have taken the preceding description, "a curious account is given of a machine worked by one horse, which, walking round a circle of forty feet, caused a cylinder, upon which thirty-two flails were placed, to revolve at the rate of twenty revolutions to one of the horse-wheel. The unthrashed straw, being laid on the circle to be described by the cylinder, must have been difficult to confine to its correct position, and awkward both to place and to remove; while the corn would be thrown about in a most slovenly manner. Another plan, patented in 1796, by John Steedman, of Trentham, has also been exhibited, by which a number of flails fixed upon a rotatory cylinder were made continually to play upon a given spot, while a circular table, revolving horizontally, brought a fresh supply of straw under their influence."

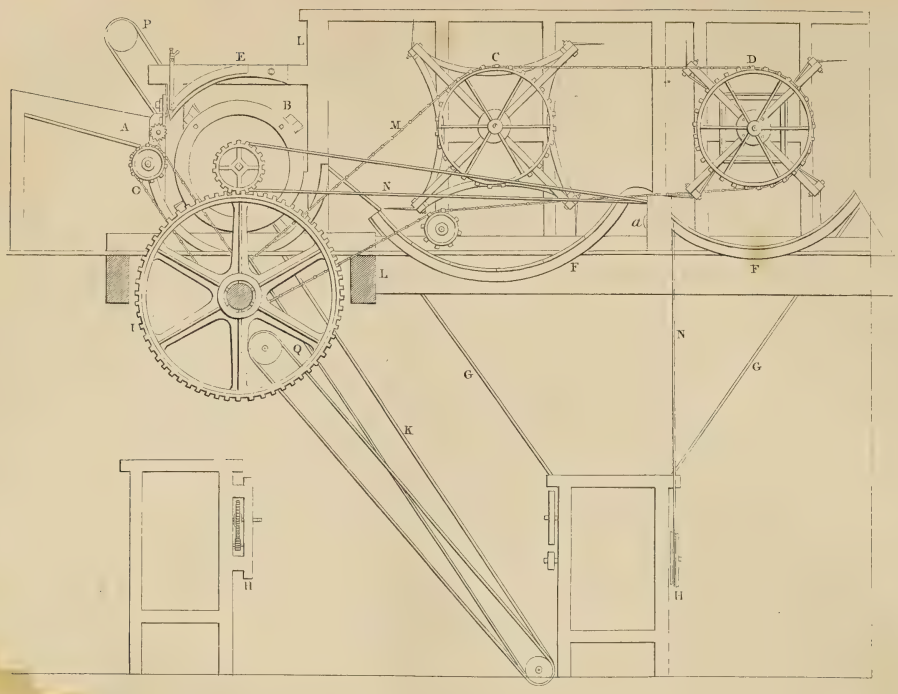
All the machines we have hitherto noticed, from Menzies' onward, may now be regarded as obsolete in practice, and as serving mainly two purposes on record,—to evoke gratitude from farmers for the superior advantages enjoyed in the machinery of the present day, and to warn young genius against any needless and wasteful expenditure of its inventive power. Another one, too, which was invented by Sir Francis Kinloch, upon hints which he borrowed from inspection of Messrs. Alderton and Smart's, went more rapidly into desuetude than any of them, and yet had the rare merit of provoking the origination of the model machine of all the best which are now in use. A large model which had been made under Sir Francis's direction was sent by him to Mr. Andrew Meikle, civil engineer at Houston Mill, near Haddington, in order that it might be tested by means of the water-wheel of

Mr. Meikle's barley-mill; and in a few minutes after it began to be tried, it was torn to pieces;—and the like fate befel a machine of full size which Sir Francis erected, a few years afterwards, for one of his tenants.

"Mr. Meikle," says Sir John Sinclair, "was at this time induced to try if the work of thrashing corn could be accomplished upon a principle, which had not been previously acted upon by any other person. It is evident, that the power required to thrash corn in a perfect manner, or even in any quantity, must be considerable; for no machine is capable of performing this operation correctly, if the scutchers do not move with a velocity of 2,500 feet in a minute. He therefore resolved to attempt thrashing by means of a cylinder or drum, placed in a horizontal position, upon the circumference of which thrashers or scutchers should be fixed, in such a manner, as to endure the necessary motion; being quite satisfied, that corn, without velocity in the thrashing-drum, could not be detached from the straw in a satisfactory manner. The attempt was made, and the success completely answered his expectations and wishes. The first thrashing-machine erected by Mr. Meikle, was on account of Mr. Stein, at Kilbagie, in Clackmannanshire, about the year 1786; and a certain proof that such a machine was then altogether unknown, may be inferred from the agreement about this erection, it being therein stipulated, that Mr. Stein was to furnish the materials, and if the machine did not answer the intended purpose, Mr. Meikle was to receive no payment for the workmanship. This thrashing-machine being successful, another, on the same principles, was erected for Mr. Selby, at Middleton, in Northumberland, which was immediately copied and imitated by several mill-wrights in that county; one of whom had the singular modesty to claim the invention, because he had previously made a model of Mr. Alderton's machine, which was constructed on quite different principles. The utility of Mr. Meikle's machine being satisfactorily ascertained, a patent for the invention was obtained, securing its benefits to him and his heirs for the period of 14 years. It is a singular circumstance, that though this patent was obtained at considerable expence, it was not acted upon. When ten years of the patent were expired, some of Mr. Meikle's friends stood forward, and endeavoured to put it in force; but there was then such a number of erections by others, that the design could not be executed, without risking an expence, which would not have been compensated by any profits that could have been gained during the unexpired years of the patent. Since the invention of this valuable machine, various improvements have been introduced, not only by the inventor, but also by others, all tending to simplify the labour, and to augment the quantity of work performed. When first erected, though the corn was equally well separated from the straw, yet, as the whole of the corn, straw, and chaff, were indiscriminately thrown into a heap, the work could only be considered as half executed. But, by the addition of shakers and fanners, all driven by the same power, the different processes of thrashing, shaking, and winnowing, are now all performed at once, and the grain immediately prepared for the market."

The modern Scotch thrashing-machine, constructed on the principle of Meikle's, and comprising all the most important improvements up to the year 1839, is represented in *Plate LXI. Fig.* 1 is an elevation, and *Fig.* 2 a ground plan; and the same letters refer in both figures to the corresponding parts. AA represent the position and arrangement of the feeding rollers, B the drum, C the first rake, D the second rake, E the apron, FF the screen, GG the hopper, HH the first and second fanners, I the connecting spur-wheel, K the elevators, LL, &c., the framing of the mill, M the rake-chain, NN the fanner-rope, O the roller-chain, P the upper pulley, for elevators of 'shorts,' Q the upper pulley for elevators of second fanners and hummellers.—The drum is the most important part; and in giving it motion, a very great portion of the moving power is expended. It being the standard for the dimensions and the velocity of the other parts, its construction and velocity are of much importance. To thrash clean, the drum requires to move with a velocity of 320 revolutions per minute, where its diameter is 39 inches, this diameter being, after numerous experiments, considered the most effective. The length of the drum, that has been in like manner determined from a train of experiments, is 3 feet 6 inches, for a machine of six-horse power. From the velocity at which the drum moves, and the force with which the beaters strike the straw, it requires to be made of materials at once light and durable. These consist of an axle of malleable iron, with arms of the best hard wood, fixed in malleable iron flanges. The best covering for the drum is sheet iron, No. 24, being both clean and light. The beaters are made of the best hardwood, 2 inches thick, and $3\frac{1}{2}$ inches deep, faced with malleable iron, steeled, and $\frac{3}{8}$ths of an inch thick on the striking edge. To prevent the straw from winding about the axle of the drum, the frame is exactly fitted to its length, so as not to have a void of more than one-half inch at each end of the drum.—The feeding rollers are about one inch longer than the drum; and they should have weight sufficient to prevent the beaters from pulling the corn faster through than the rollers pass it, and should present the corn to the beaters as directly as possible. These objects are attained by solid cast-iron rollers of 4 inches diameter. Some corn from its nature, and others from its state, requiring a greater number of strokes to thrash it than others, the feeding rollers are fitted up so as to

1



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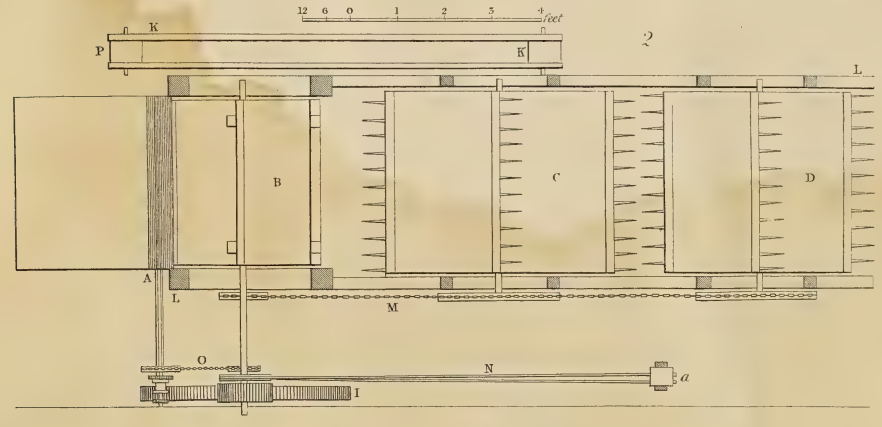
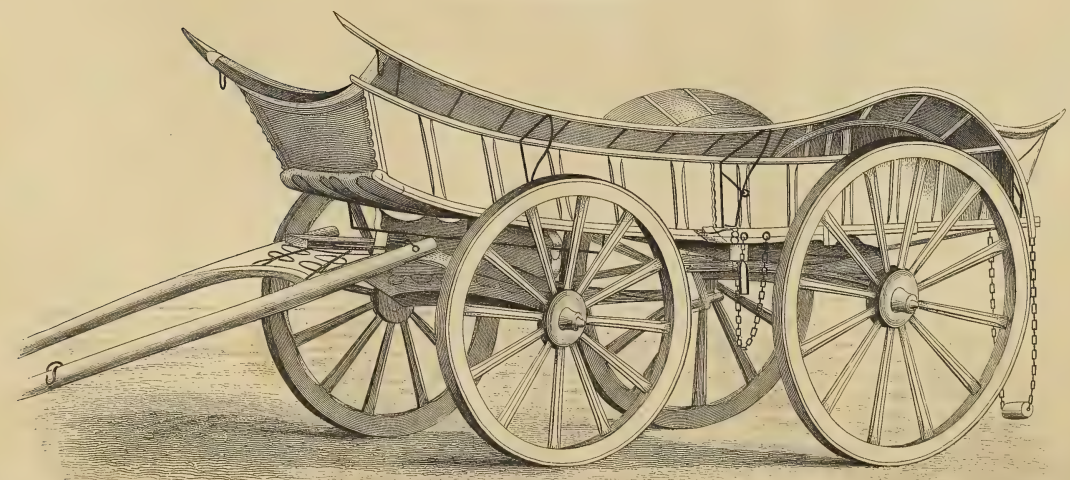


Narrow Wheel Hoop Waggon



admit of two rates of velocity,—one in which they make one revolution while the drum makes $5\frac{3}{4}$, and another in which they make one while the drum makes 4; and these two velocities have been found sufficient for all cases. The best form of fluting for the feeding rollers is, for the upper one a concave flute, and for the under an angular flute; and the most approved gearing for working them is two pairs of spur-pinions, on parallel spindles with a sliding clutch between the pairs of driving pinions. This pair of pinions has each a round eye which admits of their revolving loose on the spindle, when not fixed by the clutch. By attaching the clutch to the one or the other of the driving pinions, the motion of the rollers is instantly changed from quick to slow, or *vice versa*, without stopping the machine. The sliding clutch is carried round with the shaft by means of a feather fixed in the shaft or spindle, and is slid by means of a lever, the long end of which rests on a plate with three notches. To change the motion of the rollers, the end of the lever is moved from one extreme notch to the other extreme; and to stop the rollers, it is removed into the centre notch. The distance of the rollers from the beaters, like their velocity, depends very much on the state of the corn to be thrashed; but as a general rule, five-eighths of an inch may be considered as very good; yet a variable distance is best,—and one of the simplest contrivances for effecting this is to have the block in which the rollers run made separate from the frame of the thrashing machine, and afterwards fixed to the parts of the frame by strong bolts with a head on one end, a fixed collar between the block and the post, and a screw on the other end working in a nut sunk into the post, so that by turning the head of the bolts, the distance may be varied at pleasure. The under roller has its centre at least four inches above the level of the centre of the drum, and neither rises nor falls; but the gudgeons of the upper roller work in a perpendicular fork, whereby they are at liberty to rise or fall as the feed varies. The best coupling for the spindles or shafts of feeding rollers is an oblong box of malleable iron, welded to the end of one part of the shaft, and receiving that of the other part.—The apron of the drum is made in the form of an arc of a circle, whose diameter is about six inches greater than that of the drum. The lower end is placed five-eighths of an inch from the rollers, and the upper about $3\frac{1}{2}$ inches above the beaters. The best position of the rakes, in relation to the drum, is when their centre is placed 10 inches above the centre of the drum, and the extreme points of the first rake 10 inches from the beaters. The length of the rakes ought not to be less than six inches more than the drum. The diameter of the first rake is 6 feet over the extreme points,—and of the second 5 feet; and both make 18 revolutions per minute. The simplest and most economical mode of communicating motion from the moving power to the first rake, and from that to the second, is by a pitch-chain, arranged as shown in *Fig.* 1.—The fans of the winnowing-apparatus are 3 feet in diameter, and 21 inches broad; and the most effective velocity is 213 revolutions per minute. The simplest method of communicating motion from the thrashing machine to the fanners is by a rope from the drum passing over the leading pulleys *a*, and on to the pulley of the fan; and for the old shoe and riddle, may be substituted an endless web moving round two small rollers. This is placed underneath the hopper, and receives motion by a belt from the spindle of the fanner; and receiving the grain as it drops from the hopper, conveys it regularly forward till it falls before the fans. The endless web moves at nearly one-fourth of the velocity of the fans. While it is less expensive, and more easily kept in repair than the shoe and riddle, it also answers better, as it presents the grain more equally to the action of the fans. The method of working the second fanners is, in general, by a motion from the machine. But when a separate power can be obtained at no great expense, as may be easily done when water is the power employed, it would be advantageous to adopt it to drive both fanners, as the regularity of their motion, requisite for producing good work, would not then be interrupted by the irregularities of the machine.—The most economical mode of raising the grain from the first to the second fanners is by elevators; and these may consist of an endless web, formed into a continued series of square or oblong boxes, with a belt on each edge of the web, revolving on two pairs of parallel pulleys; but though the sides and bottoms of the boxes are formed of the endless web, their ends are of wood. It is obvious that the length of the elevators depends on the height that the grain has to be raised; the width of the boxes is regulated by the mouth of the fanners' spout; and their depth is about $2\frac{1}{2}$ inches. The velocity of the elevators is about 180 feet per minute; and the motion is communicated to them by the upper pulleys. The elevators for the 'shorts' are constructed on the same principle, and of the same materials, only larger.—The screen is made of cast-iron, hoop-iron, or wood; the spaces between the spars are squares, whose sides measure $1\frac{1}{2}$ inch; and the spars, when of cast-iron, are five-sixteenths of an inch thick, and half an inch deep. The screen would with decided advantage be extended under the drum; but this could be done only in barns of greater elevation than most at present possess. The length and breadth of the top of the hopper are regulated by the length and breadth of the screen, and the height of it by the elevation of the barn. The sloping of its sides should not, however, be less than 50°.

The suitable dimensions of the lower barn for a thrashing-machine of two-horse power, are 27 feet long, 16 broad, and $7\frac{1}{2}$ high; for one of four-

horse power, 36 feet long, 18 broad, and 8½ high; for one of six-horse power, 40 feet long, 20 broad, and 9 high; and for one of eight-horse power, 44 feet long, 21 broad, and 9 high. A suitable drum for a machine of two-horse power is 2½ feet long, and makes 180 revolutions per minute; for one of four-horse power, is 3 feet long, and makes 300 revolutions per minute; for one of six-horse power is 3½ feet long, and makes 320 revolutions per minute; and for one of eight-horse power, is 4 feet long, and makes 340 revolutions per minute. Suitable feeding-rollers for a machine of two-horse power are 2 feet 7 inches long, and make one revolution for every 4½ or 6½ revolutions of the drum; for one of four-horse power are 3 feet 1 inch long, and make one revolution for every 4¼ or 6 revolutions of the drum; for one of six-horse power are 3 feet 7 inches long, and make one revolution for every 4 or 5¾ revolutions of the drum; and for one of eight-horse power are 4 feet 1 inch long, and make one revolution for every 3¾ or 5½ revolutions of the drum; and all, for whatever amount of horse power, have the same diameter. The form of the apron, the position of the rakes, the diameter of the fans, and the form of the screen are the same for all powers; but the diameter of the rakes is variable; and the breadth of the fans for a two-horse power is 15 inches, for a four-horse power 18 inches, for a six-horse power 21 inches, and for an eight-horse power 24 inches.

The drum of some thrashing-machines is armed with beaters, and that of others with scutchers. This diversity occurred even in the original machines of Meikle's patent; and it has been considerably modified and extended in subsequent inventions. The beater stands out rectangularly, and strikes with a flat edge; and the scutcher stands out at an acute angle, and strikes with a somewhat sharp edge; and, in improved machines by different inventors and millwrights, the latter has a considerable diversity of both inclination and form. The action of a beater may be understood by supposing a handful of corn to be held in the hand, and to have its ears struck with the flat sides of a thin strip of wood; and the action of a scutcher, by supposing a sharp blow to be given, not on the ears, but in the direction of them, and not with the flat sides of the strip of wood, but with its thin edge. Beaters appear to do always best, as to at once the quantity, the quality, and the cost of the work, in cases of heavy corn, loose in the husk, wheat, pease, and beans; and scutchers are cheaper, and sometimes more efficient, in all or most cases of barley and oats. But, to adopt the opinion and the words of Mr. Ransome, "although the operation of scutching may be performed at less expense of power, if partially executed, and that a greater quantity of straw may pass the machine, and consequently more corn may be obtained in a given time, yet, unless the scutchers are placed very near the concave, the work will be imperfectly performed, and much of the corn will remain in the straw, and escape. But, if placed so near as is requisite for clean thrashing, the liability to break off the ears will be increased, which will involve the need of rethrashing; and the friction, from the narrowness of the interval, will then require, to the full, as great power as the beaters." An improved system of beaters was introduced to notice, in 1839, by Mr. Ritchie of Banff; and consists in the use of eight half beaters instead of four entire ones,—four of the halves being placed intermediately to the other four,—each having but half the resistive power of an entire one,—and all so operating as to equalize the aggregate resistance by means of the increased frequency and double distribution of the strokes.

The shaker of most thrashing machines consists simply of revolving rakes, and, in very many instances, is so constructed as both to involve very considerable waste of moving power, and to allow a considerable portion of the grain to be carried away.—A new mode of shaking, invented in 1839 by Mr. Docker of Finden in Banffshire, comprises a peculiar arrangement of two series of light batons of wood by means of cranks, to which each series are separately attached, the batons 1, 3, 5, &c. forming the one series, and the batons 2, 4, 6, &c. forming the other; and their motion is saltatory and alternately progressive, and causes the straw to pass both vertically and horizontally forward.—Another shaker, invented in the same year by Mr. Ritchie, is the same in principle as Mr. Docker's, but differs slightly in the method of producing the motion of the batons.—A shaker, invented in 1840, by Mr. Archibald Ainslie of Peaston, is simply a large skeleton cylinder, framed of wood covered in the interior with trellis-work, but entirely open at both ends. It lies at an angle of about 13°, and rests upon four plain square-edged pulleys; and the driving of two of the latter by the machine, gives motion by contact to the cylinder.—A small shaker of the common rake-form is usually placed between the drum and the cylinder, by which the straw is delivered into the latter; and when a portion of straw has entered the cylinder, it is carried round till it reach the apex, when it falls to the lower side at a point somewhat in advance of that at which it first began to ascend. When the portion of straw has again reached the apex, a second fall occurs to a point still more in advance, and so on until discharged at the lower end. A succession of such parcels of straw are, of course, in constant progress through the cylinder, rising and falling from five to seven times in their passage.—An improvement of a very simple and obvious kind, introduced in 1840 by Mr. Shennan of Lairdlaugh in Dumfries-shire, consists in the application of a screen in the place of the second shaker commonly employed. The screen lies at an angle of about 20°, jointed at the upper end to the mill-frame, and is kept in rapid vibration by a short crank

applied at the lower end, and moving at a rather high velocity.

The Scotch thrashing-machines in ordinary use throughout the country, when viewed in the aggregate, are far from being in a satisfactory or creditable condition, and do not by any means display the amount of excellence and efficiency which the history of Meikle's invention and of the many subsequent improvements on it might lead us to expect. "Most of the machines in present use," said an account in 1832 which instructively points out some permanent and general causes of their defects, "are either ill-calculated for a simultaneous action of their component parts, or they are so loaded with machinery that the moving power has a difficulty in overcoming their weight. It is very easy to overload a horse-power thrashing-mill with a multiplicity of wheels and pinions; and it will be found that the least failure of power under the ordinary thrashing-power leaves much of the straw unthrashed; the short heavy portions, called in Scotland the roughs or shag, which should descend into the second hopper, will fall down among the good grain, and create a vast additional labour in separating what the mill ought to have done. These heavily constructed machines are great evils anywhere, but especially in the interior of the country, whence carriages are long and heavy to sea-port market-towns, and hence, where the obtaining of water-power to thrashing-mills is so very desirable on account of the horses. From what we have seen and experienced in the matter, we have no hesitation in affirming, that numerous as thrashing-mills are in this country, few of them are constructed upon the correctest principles, and that much emendation may be made in this department of mechanical agriculture. Indeed, we have seen a mill constructed of a water-wheel belonging to one mill, the shafts and drum to another, the rake to a third, and the winnowing part to a fourth. This mill, when finished, cost a hundred guineas; it thrashed well; but how could a machine constructed of such patch-work be expected to do all its work satisfactorily? It may suffice to mention, that it required repair twice or thrice every winter. That machines of this description will sometimes be erected, need not excite our surprise, when we reflect on the circumstance, that many of the country millwrights set up in business with very limited capitals. They cannot procure a sufficient stock of patterns, which are calculated to form parts of the same machine, but are obliged to borrow patterns from neighbouring millwrights or founders. Besides, many millwrights think, that if the thrashing part of the mill, the drum, and its immediate mover the spur-wheel, be good and substantial, and finely hung, that all the rest are of secondary consideration. They think they show their engineering powers to the greatest degree in the construction of these parts. The overshot water-wheel may move with the velocity of a fly one, or the horses be obliged to walk at the rate of five miles an hour before the drum can be brought up to the thrashing speed, or the shakers and fanners may half choke and blow every thing before them; these may all occur from time to time without exciting much emotion, so that the drum perform its part with firmness and steadiness, at the true velocity. We are persuaded farmers just take such mills as are erected for them, for they generally do not possess sufficient knowledge of the matter to enable them to detect any error in the construction of them; and, after having got them erected, and paid for, their wounded pride will not allow them to say one word against their own machine. We do not remember of ever having heard a farmer confess that he had a bad thrashing machine, though an examination of all the parts when at work, the oppressive effects produced on the animals, and the quality of the work performed, might soon convince any one that the machine might be much better than it was. The ill-judged desire of the farmer to have a mill that will not cost much money, often leads the millwright to adopt expedients in its construction, which he is conscious are not suited to work well together. This is one reason among many others to prove the propriety of landlords erecting thrashing machines at their own expense upon the farm-steadings, and of giving the tenants the use of the mills, as well as the steadings, and of obliging them to keep the mills in repair, as in the case of the buildings."

The thrashing-machines of England have risen from a broader origin, and comprise a greater diversity of structure, than those of Scotland. In 1795, a machine was patented by Mr. Wigfull of Lynn, which attempted to combine the impulse of the flail with that of revolving beaters, but which, though much extolled at the time, soon passed into neglect. Its beaters, instead of being fixed on the drum, were loosely attached by means of brief chains, so that, when the drum was in rapid motion, they were flung by the centrifugal force with great velocity against the corn, which passed between two rollers and was held long enough to be thrashed, and then, by means of a shaking screen and an endless web, was carried forward to the action of a winnowing apparatus.—At a later period, a machine was introduced by H. P. Lee, Esq. of Maidenhead-Thicket, which embodied the principle of feeding without the aid of rollers, and contained the germ of the whole plan on which many of the English thrashing-machines of the present day are formed; and during the succeeding forty years, inventions and improvements, too numerous and diversified to admit of being profitably enumerated, were flourished before the public view, and secured by patents, and, in several instances, rewarded by honorary medals of the Bath Society and the Society of Arts.

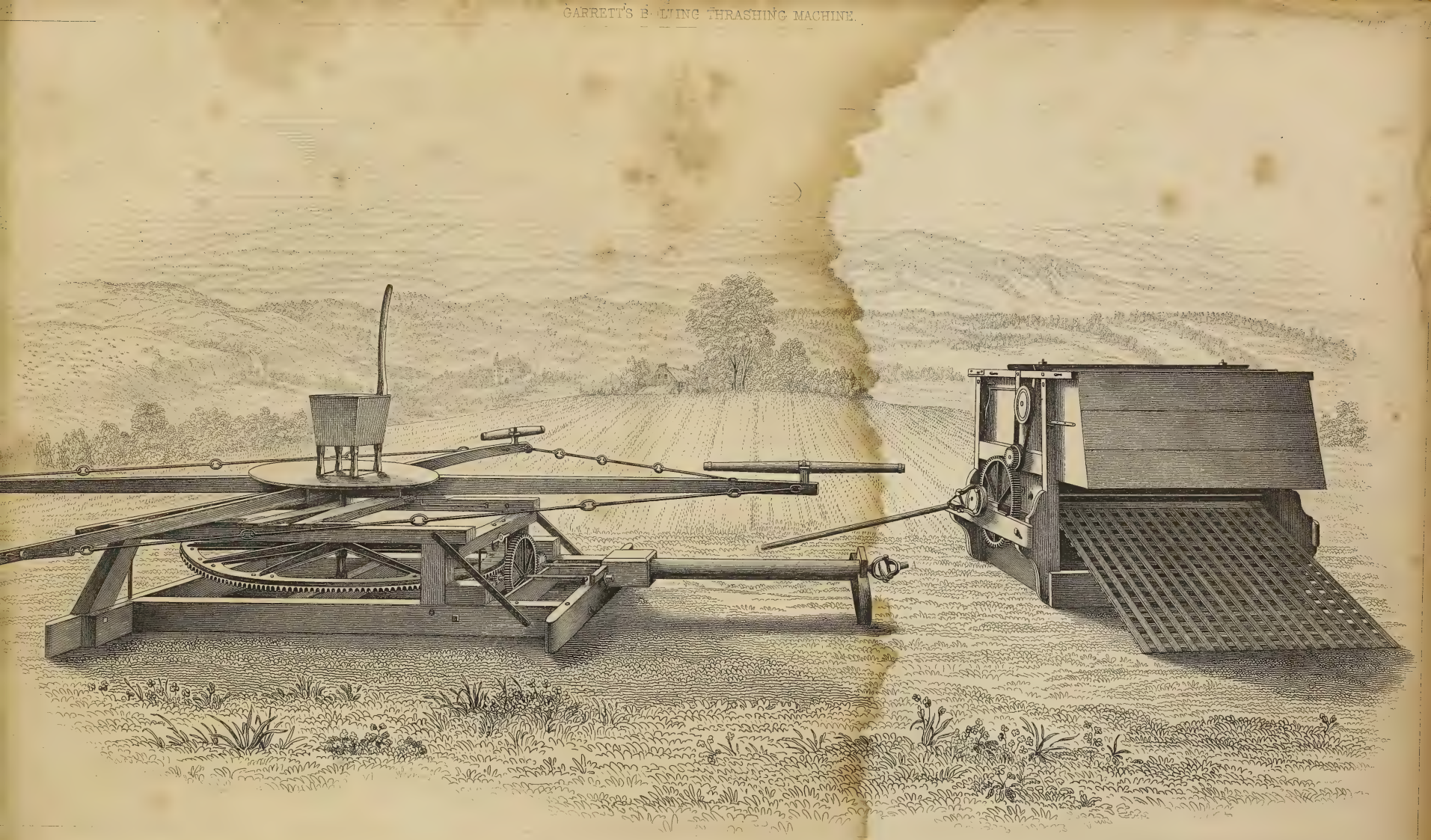
The thrashing-machines now in general use through the eastern counties of England do nothing but thrash, and have neither circular rakes nor fanners attached to them, and are mostly portable, and often carried along, in an itinerating manner, from farm to farm, and let temporarily out to any farmer who wants them. "The beaters, four, five, or six in number," says Mr. Ransome, "are so placed round the drum that their beating edges radiate from the centre. These strike upon the straw, which is passed along a feeding-board placed at an inclination of about 30°, tending to a point equidistant from the centre and upper part of the circumference of the drum. The concave or screen which surrounds the drum describes the third part of a circle, and is formed alternately of iron ribs and open wire-work in segments, so placed that its inner surface may be brought into near contact with the edges of the revolving beaters, and admitting of adjustment by screws to increase or diminish the distance. The usual plan is to place it within about 1½ inch space at the feeding part, and gradually to diminish the distance to an inch or ¾ of an inch at the lower end, where the straw is delivered upon a fixed harp or riddle, through which such part of the grain as is not driven through the wired part of the concave falls, while the straw is removed by forks. The thrashing part, commonly called the barn-work, occupies a space of 6 feet by 4½, and together with the apparatus by which motion is communicated (which is made either for two, three, or four horses' power), may at pleasure be elevated upon a pair of wheels and axle, and thus removed by two horses."—One of the most highly improved and most efficient and economical of these machines is Garrett's four-horse power, which is figured in its travelling position in *Plate LX.*, and is described as follows in its manufacturer's catalogue:—"The requisite speed of the drum is gained by three motions, or pairs of wheels, instead of two only, as was formerly the case; and this alteration, combined with the general improvements throughout the machine, has considerably added to its ease in working, and lessened the wear and tear. It is fitted with an iron horse-wheel, turned on the upper and under surfaces of the rim in a lathe, to admit of toothed segments of eight parts, securely bolted to the rim with a seating of wood between, rendering the wheel perfectly true, and gearing properly with the pinion wheel that it drives, instead of having cogs cast on the rim as heretofore; so that when the teeth are worn or accidentally broken, one or any number of parts may be replaced by the attendant of the machine, without a mechanic; it is also turned on the upper surface of the rim, to afford a true bearing for the friction wheel. The drum or thrashing cylinder is made entirely of iron, with five beaters, peculiarly formed of wrought iron, extremely light and strong, occupying less than the space of four wood beaters, and thus giving one-fifth more thrashing power without increased speed or friction. The concave that surrounds the drum is likewise formed of wrought-iron ribbed plates, rendering the whole of the thrashing part less liable to breakage and very easy to repair. There is a bridge or cover of iron for the leading bar, which has an extra joint and bearing outside the horse-walk, so that that part of the bar which the bridge covers lies horizontal, that the horses may step over, without a possibility of injury; and being attached to the horse frame with a bolt only, it is easily taken off for the convenience of carriage. This addition is the more essential when the barn floor, upon which the thrashing power stands, lies higher or lower than the horse-walk; as the end of the spindle, next the barn-work, may incline upwards or downwards, as the situation may require. An arrangement is made for attaching the connecting bar to either side of the thrashing part, by shifting the driving wheel of the drum, so as it may be worked, with equal convenience, from either side of the barn or stack. The instrument used for loading and unloading the machine is a lever purchase, readily applied and managed by one man, and is extremely portable. An additional concave to surround the drum is also provided; and that, being substituted for the one used for general purposes, will effectually draw clover, vetchling, and other small seeds."

The bolting thrashing-machine is used for wheat in cases where the straw is required to be tied in bolts or bundles for sale in large towns, or in which it is wished to be perfectly straight and regular for particular purposes in the country; and when the machine is so constructed as to work well, it neither bends the straw, nor bruises it, nor in any other respect injures it. "This machine is not very dissimilar in general character from the Suffolk portable thrashing-machine, with the exception that the drum and concave are made of sufficient width to admit the sheaf lengthwise of the straw instead of presenting the ears foremost. The drum is not a skeleton with beaters, but is a cylinder entirely cased with plate iron, and forms what is called a 'whole drum.' Upon this the beaters, eight in number, are placed longitudinally; they are formed of small strips of iron projecting not more than ¼ of an inch. The concave extends about three-fifths of the circumference of the drum; and the sheaf is introduced between two feeding rollers, as in the older machines, in order to prevent too great a quantity or too thick a wad from choking and clogging the machine, which necessarily requires to be adjusted so as to leave but little space between the drum and concave. When this machine is required to thrash beans or pease, two wooden beaters, projecting about an inch from the surface of the drum, are added, and the concave is set at a proportionate dis-

GARRETT'S PORTABLE THRASHING MACHINE
(as packed for Travelling)

A. Fullarton & Cº London & Edinburgh.

GARRETT'S B[illegible]LING THRASHING MACHINE.



A. Fullarton & Co. London & Edinburgh.

Engd by G.H. Swanston, Edin.

tance." A highly improved variety of this machine, made by Messrs. Garrett & Son, is figured in *Plate LXII.*

Earl Ducie's thrashing-machine has been introduced to public notice within the last six years; it possesses both a high degree of merit and a considerable amount of novelty; it not only thrashes corn and winnows it, but sacks the grain for the market; it was pronounced by the judges at the Shrewsbury Meeting of the Royal Agricultural Society in 1845 "a powerful machine, meriting high commendation and encouragement, although possibly adapted to the very large rather than to the moderate-sized farm;" and declared by Mr. Ransome "excellent in the greater part of its detail, and the most complete of any that had fallen within the range of his observation." The following account of it is abridged from a description by Lord Ducie's manager, John Morton, in Mr. Ransome's volume: — "This machine is worked by a steam-engine of six-horse power. The corn is brought from the stack upon waggons running along a tram-road upon an inclined plane, to the doors of the building, whence, sheaf by sheaf, it is thrown by children into the buckets of an elevator, which, in its rotation, carries them to the feeding board. This feeding board is placed at a tangent from the drum parallel with its top; and, as in Lee's machine, and the portable machines in Suffolk and Norfolk, the feeding rollers are dispensed with; an endless web gradually carries the unthrashed straw to the feeding mouth, from which the revolving scutchers rapidly convey it to the concave. The drum is about 18 inches diameter, formed of sheet iron strained round a cast iron skeleton, accurately turned. Upon this the beaters, or rather scutchers, formed of angle iron with its edges planed, are so placed as to describe an angle with the surface of the drum, pointing forward in the direction of its motion; these project about seven-eighths of an inch. The screen, or concave, incloses the drum to the extent of about one-third of its circumference, and consists of four or five arched pieces of grating, three inches wide, jointed together. It is made of cast iron bars, having a square section placed so that every one shall present an edge to the passage of the straw, uniting (as is not uncommon in other machines) the fluted concave of the Scotch machine with the wired grating of the English ones. The screen is supported on iron bolts, so that it approaches to within about one-eighth of an inch of the edge of the scutcher. Spiral springs surround these bolts, which permit the bars of the concave to yield when too much pressure may at any time occur between them and the revolving drum. The grain is thus separated, most of it passing through the screen of the concave; but in order that no grain shall be allowed to pass away with the straw, it is thrown upon the shaker below. This is a moveable harp or screen, and is made of spars $\frac{3}{4}$ of an inch from one another, 2 inches deep, $\frac{3}{4}$ of an inch wide, and 6 feet long; they are 30 in number, and are thus arranged over a width of 3 feet 9 inches. These spars are fixed to two pair of frames,—the odd numbers, 1, 3, 5, &c., being attached to one pair, and the even numbers, 2, 4, 6, &c., to the other pair. These frames are supported by two iron shafts, each having two cranks projecting $3\frac{1}{2}$ inches on each side of them; the frames are attached to these cranks by arms with brasses, in which the cranks revolve; the shafts are connected together by a rod, so that they both move at the same time. In the revolutions of the cranks, everything attached to them also revolves; so that each point of the arms, frames, and spars revolves about a centre belonging to itself only. At the same time, the regularity in the length of the crank, and the uniform motion of the two shafts, has the effect of keeping the frames always parallel; their position at any one point being parallel to their position at any other. The blows occasioned as each series of spars strike the straw from beneath, effectually remove every particle of loose grain, while the shaker rapidly carries forward the straw, and at its termination deposits it in the straw-house, while the corn sifted out by its action falls before the blast of a fanner; and all the light grain and short straws thrown out by the first winnowing into the light corn spout is then taken up by another elevator, deposited again upon the feeding board, and passed a second time through the drum, in order effectually to separate any that may remain. After passing through another winnower, the thoroughly cleaned corn is taken up by a third elevator and dropped into a hopper, through which it passes into a sack, which is placed on a weighing machine, and it is there weighed and left thoroughly fit for market."

The choice of the moving power for a large thrashing-machine is sometimes a subject of grave consideration. Wind-power is inconstant, and not available for work during more than from 6 to 8 months in the year; so that, wherever thrashing work may be wanted at all seasons, this power must be supplemented by a horse-mill or a steam-engine. The cost of erecting a wind-mill, of the best materials and construction, including tower, may be fairly estimated at £350, exclusive of the carriage of building materials. Its annual tear and wear, from constant exposure, is very great, and this, whether working or not; and it requires the constant attendance of a person, to watch and regulate its motions.—Water may be regarded as the best of all moving powers; and is, under almost all practicable circumstances, the most economical; but of course can be available only in the immediate vicinity of a stream, of sufficient volume, and with a sufficient fall. The expense of a substantial water-wheel, including

mason-work of fall or mill-race, varies from £70 to £110; the average may be taken at £90. The forming of the water-course and tail-race seldom exceeds the cost of making a large open drain of the same length; but, in many cases, there is the additional expense of forming a reservoir for collecting and preserving the water, which, with the water-course and tail-race, may occupy a space equal to two acres of ground. The repairs of a water-wheel are trifling; and it requires almost no superintendence while working. If the supply of water is abundant, it is available at all times, without interrupting other labour.—Horse-power is facile and always available; but the expense of it is comparatively high, and cannot, without difficulty, be very closely calculated. The expense of a horse-wheel for a Scotch machine, including the building to cover it, cannot be reckoned at less than £120; and on a farm extending to 250 or 300 acres, a horse-mill occasions the keeping of a pair of horses more than would be necessary for labouring the farm, if steam or water-power were employed. The expense incurred by a pair of farm horses has been variously estimated by eminent agriculturists, who have turned their attention to the subject. Mr. Middleton of Middlesex estimates the expense of food, harness, shoeing, farriery, interest on purchase, decline in value, and insurance, at £157 10s. per annum; Mr. Brown of Markle, at £135 1s.; Mr. Kerr of Berwick, at £120; the General Report of Scotland, at £94 14s. 6d.; the West Lothian Report, at £90; and the Dumbarton Report, at £80. The average of these various estimates is £112 17s. 7d.; and this may be assumed as the average expense incurred by keeping an additional pair of horses. To this is to be added the expense of other two pairs of horses for every day the mill is employed; and being the severest labour to which farm horses are ever applied, it not only wears them out faster, but, from overheating them, occasions many diseases. Add to this, that while the horses are engaged at the thrashing machine, field-labour, however urgent, must, for the time, be suspended. The usual diameter of the horse-walk for a Scotch machine is 25 feet. The best speed for the horses is their ordinary pace, equal to 2½ rounds of a horse-walk of 25 feet diameter, per minute, or about the rate of two miles per hour. When a spur horse-wheel is employed, the diameter is 28 feet; and when a face-wheel, the diameter is 18 feet. The face-wheel seems preferable, being not only easier for the horses, but admitting of the least complicated and most advantageous mode of connection with the thrashing-machine. Thus, with a face-wheel, the mode of connection is by a horizontal lying shaft, with a large spur-wheel inside driving the drum-pinion, while the rollers and rakes, by means of a pitched chain, receive their motion from this lying shaft, without the intervention of other shafts and wheels.—Steam power is available at all times, without interrupting field-labour; and, when water power cannot be had, saves the expense of a pair of horses. With a properly constructed thrashing machine, a four-horse power steam-engine, on the high-pressure principle, is capable of doing as much work as can be done with a six-horse engine, applied to one of inferior construction; and hence it may be inferred, that, for farm purposes, a four-horse engine may be held as a sufficient power. Assuming this, the expense will be, for the engine, £110; for the engine-house and chimney-stalk, about £70; and for making a well, from £5 to £7. The engine requires the attendance of a handy person, who may also act as fireman. The cost of repairs does not much exceed that of the horse-mill. The only other item is the cost of fuel. If chew-coal or culm can be obtained, its price, exclusive of carriage, may be taken at 3s. 6d. per ton; and ten cwt. will be the consumpt per day of ten hours.

Whatever be the moving power used, it should be made to act with an equal force throughout the whole operation of thrashing the same stack. An unequal application of power deceives the man who has the charge of supplying the mill with sheaves. If he have a dread of uncertainty, he may put in too much at one time, when the machine will not be able to thrash the straw clean of its corn; and if, on the other hand, the sheaves be supplied too scantily, the wind of the winnowing-machine may prove too powerful, and blow away some of the good grain among the chaff. To insure regularity of motion, in the case of horse power, it is necessary for the man who drives the horses to walk round in a contrary direction to them, so that he may nearly meet each horse twice in the course of one circuit; and, in the case of water power, which will gradually fail as the height of water in the dam sinks down, the sluice should be drawn farther up, so that the same depth of water may always flow upon the wheel. A short time's experience will enable any man who has the charge of a thrashing-machine to acquire these minutiæ in practice; and the neglecting to attend to them, may cause a greater loss in a waste of grain, or, what is always valuable on a farm, in a waste of time, than may at first sight be credible. When any small proportion of grain is either taken away among the straw, or blown away among the chaff, whenever a stack is thrashed, it is not only itself lost in the form of grain, but may afterward appear in the shape of growing corn among a green crop,—the manure for which is seldom fermented, but is carted out of the courts and applied to the land; and it may give rise to a very injurious fama against the credit of the farmer's management.

Hand thrashing-machines are now made, of various sizes and of excellent construction, by some of the principal agricultural implement manufacturers, for use on small farms; and in

all instances, they merely thrash corn, or leave it in the same condition as the flail, without performing any winnowing operation. One of the oldest of any note was introduced to public notice about twenty years ago by the Very Reverend Principal Baird; and this consists merely of a chain with its beaters and other thrashing appliances, and has a toothed pinion on its axis, and is worked by means of a toothed wheel, with handle and large regulating fly-wheel,—the pinion having 6 teeth and the wheel about 50, so that, by making 20 revolutions of the handle per minute, the chain with its beaters is impelled at the rate of 200. This machine, however, absorbs a comparatively great amount of power, and requires the labourers employed upon it to be relieved at intervals, and has never come into general use. Ransome's, which obtained the commendation of the judges at the Liverpool meeting of the Royal Agricultural Society, is made on a different principle, and moved by means of a lever on the one side and a crank handle on the other, and worked by four men, who relieve one another by change of motion. Two of the most convenient in use, and at the same time distinguished for efficiency, are Garrett's large-sized hand thrashing-machine, which may be worked either by four men or by one horse, and Garrett's middle-sized thrashing-machine, which is just equal to the power of two men.

The quantity of work done by the thrashing machines of former days, particularly when compared with the cost of erecting them and the amount of accompanying labour in working them, was very unequal, and throws great light, in the way of comparison, upon the working efficiency of the best machines of the present day. The following instances, extracted by Mr. Ransome from the Agricultural Reports, may be taken as a good specimen:—

	Thrashing per Day.
In the reports of Roxburgh and Selkirk, in 1796, R. Douglas states that mills by water, or with 4 horses, would do great execution.	25 or 30 bolls, or from 150 to 180 bushels.

In the report of Norfolk, in 1804, Arthur Young gives an account of machines which belonged to the following parties:—

Droziers, Reedham, built by Wigfull, cost £120, worked by 7 persons and 6 horses.	40 co. wheat, or 50 co. barley, or 60 co. oats or pease.
Farrow, Shipdam, built by Wigfull, worked by 7 persons, and by 4, 5, or 6 horses.	20 co. wheat, or 30 co. barley, or 40 co. oats or pease.
Beck, Castle Rising, built by Wigfull, cost 200 guineas, worked by 6 persons, and 4, 5, or 6 horses.	32 co. wheat, or 64 co. barley, or 80 co. pease.
Whiting, Tring, built by Fordyce from Scotland, cost £200, worked by 6 persons and 6 horses.	24 co. wheat, or 55 co. barley, or 63 to 84 co. oats.
Bevan, Riddlesworth, built by an engineer from Leith, cost £100, worked by 10 men and 8 horses.	40 co. wheat, or 40 co. barley, or 50 co. oats.
Coke, Holkham, cost £600, worked by 12 men and 8 horses.	64 co. wheat.
Reeves, Heverland, built by Assby, Blyboro', cost 100 guineas, worked with 2 or 3 horses.	30 co. wheat, or 32 co. barley, or 40 co. pease.
Styleman, Smithsham, cost £300, worked by 10 persons and 8 horses.	80 co. wheat, or 120 co. barley, pease, or oats.
In the report of Kent, R. Boys, in 1805, remarks on the only thrashing-mill then in Kent, which, by a number of improvements, and after many alterations, he finds to answer extremely well; and he states that it requires 4 horses and 12 men to work it.	24 qrs. wheat, or 32 qrs. barley, or 40 qrs. oats.
In Sir John Sinclair's *System of Husbandry*, published in 1812, we find an account of R. Kerr's machine, which, with 6 horses, 4 men, and 4 women, would thrash	50 bolls, or about 300 bushels of wheat.

An ordinarily good Scotch thrashing-machine of the present day, even though it possess none of the improvements which have been introduced within the last ten years, if a two-horse power, ought to thrash and clean, on the average, 14 bushels of wheat or 20 of barley or oats in the hour, and requires an attendance of 5 persons,—if a four-horse power, ought to thrash and clean 26 bushels of wheat or 32 of barley or oats per hour, and requires an attendance of 7 persons,—if a six-horse power, ought to thrash and clean 32 bushels of wheat or 38 of barley or oats per hour, and requires an attendance of 9 persons,—and if an eight-horse power, ought to thrash and clean 38 bushels of wheat or 44 of barley or oats per hour, and requires an attendance of 10 persons. A good four-horse power portable thrashing-machine, such as is made by the Messrs. Ransome and the Messrs. Garrett, ought, on the average, to thrash about 40 bushels of wheat or of mown barley in the hour, provided the crop have been reaped in fair condition; and two of these machines, when worked under stimulated exertion at the meeting of the Royal Agricultural Society in 1841, actually thrashed each a little upwards of 61 bushels; yet every such machine suffers enormously in comparison with a Scotch one, as it thrashes only and does not clean, and requires to be attended by no fewer than eight men and five boys. A good English hand thrashing-machine, worked by a power of four men, ought to thrash from 10 to 12 bushels per hour of wheat of average yield and in fair condition, but will thrash proportionally less of wheat which is either poor in yield, long in the straw, or reaped with the scythe.—*Ransome's Implements of Agriculture.—The Annual Register of Agricultural Implements.—Reports upon Shows of Agricultural Implements in the Journal of the Royal Agricultural Society.—The General Report of Scotland.—Communications to the Board of Agriculture.—Cata-*

logue of the Highland Society's Museum.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Dickson's Husbandry of the Ancients.—Jahn's Hebrew Antiquities.—Dr. Dickson's Practical Agriculture. — Society of Gentlemen's Complete Farmer.—Hunter's Georgical Essays.—Low's Elements of Agriculture. — Catalogues of Garrett and other principal Agricultural Implement Makers.—Sinclair's Code of Agriculture.—Useful Knowledge Society's Reports of Select Farms.—Doyle's Practical Husbandry.

THREAF. A handful, pottle, or bundle.

THREAVE. Twenty-four sheaves of corn.

THRESHING. See THRASHING.

THRIFT,—botanically *Armeria.* A genus of ornamental, small, evergreen plants, of the plumbago family. It was formerly included in the genus statice; and, as now constituted, it comprises two indigenous species, and about 18 exotic ones,—all of which have been introduced to Britain, and deserve a place in the flower-garden. One species is a greenhouse shrub of about 2 feet in height; and all the others are hardy perennial herbs, varying in height from 4 to 25 inches. Most of the species have pink flowers; and the others have either scarlet, crimson, purple, flesh-coloured, or white flowers. Nearly all thrive best in a soil of sandy loam; and all are propagable by radical division.

The sea-side thrift, or sea-pink, *Armeria maritima,* called by the older botanists *Statice armeria,* abounds on the marshy sea-shores of many parts of Britain. It occurs chiefly in places which are regularly overflown at high water; and it sometimes adorns great tracts of sea-marsh, and renders them deeply verdant at all seasons, and brilliantly beautiful during the season of bloom; and it is raised and cultivated in many a flower-garden as an edging for borders. Its leaves are very narrow, short, and plain; its stems seldom rise more than 4 inches high; and its flowers grow in small dense heads at the top of the stems, and have a red or flesh colour, and bloom from May till July.—The mountain thrift, *Armeria montana,* grows wild on some of the lofty mountains of the Scottish Highlands, and is about the same height as the preceding, and has pink-coloured flowers, and blooms in May and June.

The common thrift, *Armeria vulgaris,* is a native of the Alps and of other cold mountains of Continental Europe, and was long ago introduced to Britain, and has long been more or less esteemed as an edging-plant for flower-borders, and is often mistaken for the sea-side thrift. Its roots are fibrous, and divide into heads; its leaves are numerous, narrow, and grass-like, and have three corners at their base, and sit close to the root-heads; the stems rise from the embrace of the mutually overlying parts at the bases of the leaves, and are naked and about 6 inches high; and its flowers grow in heads, on one common scaly calyx, at the top of the stems, and have a pale purple colour, and bloom from June till August. A variety of this species has bright red flowers, and makes a much better appearance, and is more esteemed for edgings, than the normal plant.—The broad-leaved thrift, *Armeria latifolia,* has much larger leaves, and much loftier stems, than the common thrift, and carries light red flowers from May till July; and it was introduced to Britain upwards of a century ago, and makes considerable claims on the cultivator's attention; but it differs from almost all the other thrifts in loving a soil of a somewhat peaty kind.

THRINCIA. A genus of yellow-flowered herbaceous plants, of the succory division of the composite order. The simple-haired species, *T. hirta,* grows wild in the grass lands of some parts of Britain; and is perennial-rooted, and has a height of about 20 inches, and blooms in July and August. Two annual species, and a tuberous-rooted one, all hardy and about a foot high, have been introduced from other countries; but neither these species, nor the indigenous one, possess much interest.

THROATING. The mowing of beans against their bending. This is done only with a thin crop.

THROATWORT,—botanically *Trachelium.* A genus of exotic, ornamental, herbaceous plants, of the bellflower family. The blue species, *Trachelium cæruleum,* grows naturally in shady woods in many parts of Italy, and was introduced to Britain in 1640. It is a hardy biennial or short-lived perennial. Its root is fleshy and tuberous, and sends out many wide-spreading fibres; its radical leaves are ovate-lanceolate, serrate, pointed, and about two inches long and one inch broad; its stems are irregularly garnished with similar leaves to the radical ones, and have a height of from 18 to 25 inches; and its flowers grow in compound, many-flowered umbels, and have a small funnel-shaped corolla of an azure colour, and bloom from July till September. This plant is propagated from autumn-sown seeds, and loves a soil of rich mould, and also thrives well and maintains itself for an indefinite period and makes a fine appearance upon old walls which contain a sufficient quantity of soil for the lodging of its seeds and the anchoring of its roots.—The name throatwort is likewise borne by a beautiful indigenous plant of the bellflower genus. See the article BELLFLOWER.

THRUSH,—scientifically *Turdus.* A large and interesting group of passerinous song-birds. They have a compresed and arcuated bill, not hooked in the point, and graduating off, in some of the species, into a resemblance to that of the shrikes; and they have solitary habits, and feed for the most part on berries or similar fruits. One great subdivision of them, comprising the blackbird and the brown thrushes, have the colours of the plumage uniform or distributed in large masses; and another large subdivision, comprising the

truest or spotted thrushes, or what the French call grives, have the plumage marked with small black or brown spots.

Three of the best known British species are noticed in the articles Blackbird, Fieldfare, and Redwing; and some others are glanced at in the article Hedge-Birds. The ring-ouzel, ring-blackbird, or stirling, *Merula torquata* or *Turdus torquatus*, is a bird of passage, and frequents highland districts. Its feathers are black, partly edged with white; and its breast is marked with a shield of the same colour.—The missel-thrush, *Turdus viscivorus*, is eleven inches long, and has a prevailingly brown colour of plumage, but is white on the under surface of the body, tinged with yellow, and profusely marked with black spots. Its eggs are 4 or 5 in number, one inch and three lines long, eleven lines broad, and of a greenish-white colour, spotted with dark red brown.—The song-thrush, *Turdus musicus*, is rather less than nine inches long, and has the under parts of the wings yellow, and is a better songster than any other of the European true thrushes. Its nest is formed of green moss and fine roots; and its eggs are 4 or 5 in number, one inch and one line long, ten lines broad, and of a beautiful light blue colour, with a few black spots.—White's thrush, *Turdus Whitæ*, is a rare and recently observed species, measuring 12½ inches in length. The species of thrushes foreign to Europe are very numerous.

THRUSH. A diseased condition of the sensible frog of the horse's foot. It results from inflammation, and occasions the secretion and discharge of a fetid, semipurulent fluid, and is remotely caused by contraction of the foot, or by the heat and foulness of the stable. It commonly has its primitive seat in the cleft of the frog; and it is supposed to drain off morbid matter from other parts of the system, so as to prevent or obviate other diseased affections; and when, on the one hand, it is suddenly checked, it is liable to occasion derangement of some other organ, while, on the other, if it be neglected or abused, it is liable to degenerate into canker. It always involves so much tenderness as to occasion limping for a few steps after the foot presses upon a stone; and it may generally be regarded as an indication of the commencement or progress of contraction in the foot; yet it does not often produce absolute lameness, and seldom impairs in any serious degree the general usefulness of the animal. The proper treatment of it is to remove or reduce the causes which excite it, to pare away ragged parts so as to lay quite bare the diseased surface, to apply lotions and brushings and soakings of any suitably diluted mineral astringent, such as a solution of blue or white vitriol or a mixture of tar and diluted sulphuric acid, and, in bad cases, to employ poultices for two or three days, or stimulating stoppings every day or every alternate day, according to the symptoms and other circumstances.

THRUSH. A disease of the mouth of cattle and sheep. See the article Aphthæ.

THRYALLIS. A small genus of ornamental exotic plants, of the barbadoes cherry family. The short-spiked species, *T. brachystachys*, is a very handsome, yellow-flowered, evergreen, hothouse climber, of about 10 or 12 feet in height, blooming throughout most of autumn, loving a soil of peat and sand, and propagable from cuttings; and it is a native of the tropical parts of South America, and was introduced to Britain in 1823.

THUJA. See Arbor Vitæ.

THUNBERGIA. A genus of highly ornamental, exotic, evergreen, climbing and twining plants, of the acanthus family. The golden-eyed species, *T. chrysops*, was introduced to Britain from Sierra Leone in 1844; and is a fair specimen of the whole genus. It has a herbaceous or sub-shrubby character, and a neat habit, and admits of being so trained as to be all-over ornate from root-crown to summit. Its leaves are opposite, somewhat heart-shaped, minutely serrated on the margin, and acutely angular at the point; and its flowers are numerous, large, delicate, and showy, and come out singly at the axils of the leaves, and have a funnel-shaped corolla with an out-spread mouth,—the eye or centre of a golden colour, surrounded by a belt of light blue, and the outer portion, comprising five broad segments, of a rich dark purple colour.—The winged species, *T. alata*, introduced from the Cape of Good Hope in 1824, and suitable for greenhouse cultivation, is the best known species, and has a deep purple eye and either a yellow or a white expanse.—Seven other species, varying in height from 3 to 10 feet, with severally scarlet, white, yellow, and blue flowers, all requiring hothouse culture, and most blooming from May till September, have been introduced from India, Nepaul, Madagascar, and the West Indies.—Most of the species love a soil of peaty loam, and are propagated from cuttings; but the winged species does best to be propagated from seeds.

THWARTIL-ILL. See Louping-Ill.

THYMBRA. A genus of curious, exotic, evergreen undershrubs, of the labiate order. The spike-flowered thymbra, or mountain Macedonian hyssop, *T. spicata*, is a native of Syria, Greece, and Spain, and was introduced to Britain about the close of the 17th century. It has a heath-like appearance; and branches out into slender, ligneous, leafy stalks of 6 or 8 inches in length, covered with brown bark; and emits from its bruised foliage an aromatic odour. Its leaves are sessile, narrow, acute-pointed, and about ½ an inch in length; its floral spikes grow terminally on the stalks, and are thick, close, and nearly two inches long; its calyxes are stiff and hairy; and its corollas have a purple colour, and are two-lipped, and peep out of the calyxes, and bloom in June and July. Two other species occur in

British collections; and all are propagated from cuttings, and require a little winter protection.

THYME,—botanically *Thymus*. A genus of ornamental, evergreen undershrubs, of the labiate order. Three species grow wild in Britain, and at least 30 have been introduced from Continental Europe and Northern Africa. Nine or ten of the species are creeping or procumbent, and all the others are erect; a small number have white, striped, or red flowers, and all the others have purple flowers; a few are 12 or 15 inches high, and the rest vary in height from 3 to 10 inches; five or six require a little winter protection, and all the others are quite hardy; two or three require a soil of rich mould, and the rest thrive in any common soil or in sandy loam; some are most readily propagated from seeds or by radical division, and the rest are propagated from cuttings; one is cultivated for culinary and medicinal purposes, and the others are merely or principally ornamental, and all are more or less fragrant, aromatic, and pungent.

The wild thyme, or mother of thyme, *Thymus serpyllum*, abounds on the heaths and the dry mountainous pastures of many parts of Britain. It has a procumbent habit, and a height of about 3 inches, and blooms from June till August. The normal plant has purple flowers and no fragrance; but one variety, called the white-flowered, has white flowers,—another, called the shrubby, has pale red flowers,—another, called the variegated, has variegated leaves,—another, called the narrow-leaved, has an odour similar to that of the leaves of the walnut-tree,—and another, called the lemon, emits an agreeable aromatic fragrance similar to that of lemons. Several of the varieties are allowed a place in flower-gardens, on account of their beauty or fragrance; and the lemon one requires always to be propagated from slips and cuttings. Pastures and moorlands overrun with wild thyme have long and generally been known to produce a superior flavour of mutton and venison; but whether they owe their excellency to the sheep and deer eating the thyme itself, or to their eating the peculiar combinations of herbage with which it is associated, or to the influence of the qualities of soil and climate which render it luxuriant, is matter of dispute.

The outdrawn thyme, *Thymus exserens*, is a native of the heaths and mountainous pastures of Britain, of very similar habit and height and time of blooming to the wild species.—The woolly thyme, *Thymus lanuginosus*, is a native of some parts of Scotland, and also grows procumbently, and carries purple flowers from June till August.

The common or garden or culinary thyme, *Thymus vulgaris*, is a native of the South of Europe, and was introduced to Britain about the middle of the 16th century. It has an upright habit, and a height of about a foot, and carries purple flowers from May till August; and it comprises one variety with comparatively broad leaves, another with variegated leaves, and another with yellowish colour and a lemon-scented odour. The variegated is cultivated almost solely for sake of its ornamental foliage; but the other varieties are cultivated for sake of at once the ornateness of their appearance, the pleasantness of their living fragrance, the essential oil which they yield by distillation, the medicinal aromatic uses of their herbage and oil, and various culinary and flavouring uses of their tops. Thyme, though strictly a perennial, becomes stunted after three or four years, and requires, at comparatively short intervals, to be reproduced. A light, dry, and rather poor soil is most conducive to its best condition; and a rich or a moist soil renders it luxuriant, but occasions it to be deficient in fragrance, and greatly tends to make it perish in winter. The situation cannot be too open. The plant may be propagated either from top-slips or parted roots in spring, planted 6 or 12 inches asunder, or from seed sown in April, broadcast or in drills; and the plantlets from seed may either be transplanted in summer or allowed to remain in the drills,—and those transplanted must be occasionally watered till they become established. In autumn, decayed stems and branches should be cleared away, and a little fresh soil scattered among the old plants. Young plantlets of thyme may be planted close along the margin of a border to serve as an edging.

THYMELÆA. See Olive (Wild).

THYSANOTUS. A genus of ornamental, herbaceous, Australian plants, of the asphodel order. The name signifies "fringed," and alludes to a beautiful fringe upon the three inner sepals. Seven or eight species—some tuberous-rooted, others fibrous-rooted, and most purple-flowered and from 6 to 15 inches high,—have been introduced to the greenhouses of Britain. The stem and branches of one, *T. intricatus*, are very curiously and complexly interwoven; the foliage of some is scanty, yet harmonizes well enough with the inflorescence; and the bloom of several, particularly of *T. proliferus*, is very abundant, while that of most remarkably combines quiet beauty with striking singularity. One of the finest in appearance, as also one of the earliest in bloom, is *T. tuberosus*, about a foot high, and introduced in 1825. Most love a soil of sandy peat, and are propagated from offsets.

THYSSELINUM. See Milk-Parsley.

TIARELLA. A genus of ornamental, exotic, herbaceous plants, of the saxifrage family. The name signifies "a little diadem," and alludes to a sort of mitred structure in the capsule. The heart-leaved species, *T. cordifolia*, is a native of North America, and was introduced to Britain in the former part of last century. It is a hardy evergreen. Its root is fibrous, creeping, and reproductive; its leaves are numerous, heart-shaped, unequally indented, and of a light green colour, and come out on slender footstalks of about 3

inches in length from the crown of the root; its flower-stems arise from among the leaves, and attain a height of from 4 to 6 inches; and its flowers grow in loose terminal spikes, and are small, of a herbaceous white colour, and bloom in April and May. Two other species of similar character, but with taller flower-stems, have been introduced from North America and Nepaul; and all are propagated by radical division.

TIARIDIUM. A small genus of ornamental, tender, blue-flowered, annual plants, of the borage family. Two species, the velvety and the Indian, both about a foot high, have been introduced to Britain from the West Indies.

TICK. A parasitical insect, similar to a louse, and infesting sheep and dogs. It is many times larger than a louse, and of a different colour, but not of so frequent occurrence. It varies in size from a pin's head to a small bean, but is commonly about as big as a pea; and when not gorged with blood, it is flat,—but, when bloated, is round and of a brown or black colour. It has six legs, and runs with much speed; and attaches itself to the skin by means of sharp claws at the extremity of the legs, and pierces the skin by means of sharp instruments in its head; and when once it fastens on a spot, it seems to remain quite fixed for several weeks or even months; and it becomes surrounded with numerous young ones, who appear at first like red points, but afterwards acquire a brown colour as they grow. It propagates rapidly; and is often found in great numbers on a single sheep; and commonly prefers the animal's neck and shoulders to other parts. It is thought by some persons to breed upon the ground, and to spend only the later stages of its existence upon sheep; and certainly it frequents some farms and districts far more than others, and is seldom found on some badly managed farms where it might naturally be expected, and cannot without great difficulty be banished from some well-managed farms and very healthy flocks where it might be supposed not at all to occur. It is, of course, a sad pest to the animals whom it affects, destroying their peace, diminishing their fleece, and disturbing the general economy of their health and growth; and it ought, in every case, to be promptly and exterminatingly attacked. One effectual remedy is rubbing with mercurial ointment, but is liable to produce salivation or dangerous exposure in unsuitable seasons or weather; another effectual remedy, at times when the mercurial ointment cannot be prudently applied, is washing with tobacco-water, but lies under the disadvantage of giving a depreciating tinge to the wool; another efficient remedy, at all times, is dipping in a solution of arsenic, but involves the risk of terrific casualties to both man and beast from the use and presence of so dreadfully poisonous an agent; another always efficient remedy is washing with a lotion of one ounce of corrosive sublimate, one-fourth of a pint of spirit of wine, and three quarts of water, but is liable, in a large degree, to the same objection as the preceding; another, almost equally efficient, and somewhat less objectionable, is washing with a lotion of two ounces of tobacco, $2\frac{1}{2}$ ounces of soft soap, 11 lbs. of white calx of mercury, and 8 gallons of water; and another, considerably less efficient, but correspondingly less unobjectionable, is the application of linseed oil or of turpentine. Careful hand-picking is practised by some shepherds; and of course is efficient as far as it goes, but, in all bad cases, is an endless and quixotic task. See the articles Sheep, Salving of Sheep, and Fly-in-Sheep.

TICKSEED, — botanically *Corispermum*. A genus of exotic herbaceous plants, of the goosefoot family. About a dozen species, all hardy apetalous annuals, blooming about the end of summer, and varying in height from 6 to 20 inches, have been introduced to the botanical collections of Britain, principally from Eastern Europe and Northern Asia; and some other species are known. Both the popular and the botanical names refer to the bug-like form and appearance of the seed.

TIDES. The ebb and flow of the sea are evidently connected with the moon's motions. The level of the ocean is slightly disturbed by the attraction which is alternately exerted and withdrawn. The waters, for a large space under the moon, being more attracted than the great body of the earth, are thus rendered lighter than those parts of the ocean which are at the same distance as the earth's centre; and, being lighter, they are forced upwards a little by the surrounding mass, which is heavier; just as water and oil will stand at different heights in the two branches of a siphon tube; or just as ice, which is lighter than water, is made to rise a little higher, on that account, when placed in water. If the earth rested immoveably upon a fixed support, there would be a tide, or rising of the waters, only on the side towards the moon. But the great body of the earth is just as free to move as a single particle of the ocean, and, if suffered to yield to the moon's attraction, would be carried just as fast. Hence, for the same reason that a particle of water, on the side of the earth towards the moon, is drawn away from the centre, or has its downward tendency diminished, so the solid earth itself is drawn away from the mass of waters, on the side of the earth farthest from the moon. It is the difference of attraction in both cases, between the surface and the centre, which causes the lightness of the waters, and the consequent elevation. It will be seen, therefore, that, taking the whole earth into view, there are always two high tides diametrically opposite to each other, and two low tides also, mid-way between the high ones. The high tides are two great waves, or swells, of small height, but extending each way through half a right angle. These waves follow the moon in its monthly

motion round the earth, while the earth, turning on its axis, causes any given place to pass through each of these swells and the intervening depressions in a lunar day, or twenty-four hours fifty minutes. What we have said with respect to the moon's influence in disturbing the level of the ocean, may be applied also to that of the sun; only, in the case of the sun, although its absolute action is about double that of the moon, yet. on account of its very great distance, its relative action upon the surface of the earth, compared with that at the centre, is but about one third as great as that of the moon. At new and full moon, when the sun's and moon's actions conspire, the tides are highest, and are called *spring tides.* But at the first and last quarters of the moon, the action on one body tends to counteract that of the other; and the tides, both at ebb and flow, are smallest, and are called *neap tides.* We have supposed the highest tides to happen at new and full moon, and the lowest at the quarters. But the waters do not yield instantly to the action exerted upon them; the greatest effect takes place some time after the attractive influence has passed its point of greatest power. Thus the spring and neap tides actually occur about a day and a half after the times above indicated. So, also, for a similar reason, the real time of high water, in the daily tides, happens about three hours after the moon has passed the meridian.

It will be perceived, from what has been said, that the sun's and moon's influence will vary with a change of distance, being greatest when the attracting body is nearest, and *vice versa.* The phenomena of the tides are modified, moreover, by the situation of the sun and moon with respect to the equator, and the particular latitude of the observer. When, for instance, the moon passes near the zenith of the observer, supposed to be in one of the temperate zones, the opposite high tide will be in the same latitude on the other side of the equator; consequently, under the above circumstances, the high tide, when the moon is above the horizon, exceeds the high tide when the moon is below the horizon; and at a point in the direction of the nearest pole, fifty degrees from the place where the moon is vertical, there will be only one tide in twenty-four hours. The different heights to which the same tide rises, in places but little distant from each other, depend upon local circumstances; as the particular form of the coast, the meeting of currents, &c. Where a bay grows narrower and narrower, like a tunnel, as it runs up from the ocean into the land, the swell of water must rise higher as the passage becomes more contracted in breadth. Thus, in the bay of Fundy, which answers to this description, and is of great extent, the tide sometimes rises to the height of seventy feet. It is frequently asked, why there are not tides in the inland seas and larger lakes. If we observe, upon an artificial globe, the very small space occupied by the largest bodies of water of this description, we shall readily perceive that there can be no appreciable difference in the action of the moon upon so small a portion of the earth's surface; the whole of the lake, or sea, therefore, becomes lighter when the moon is over it, and there is no heavier mass of water ninety degrees distant to force it above its natural level.

TIGER-FLOWER,—botanically *Tigridia.* A small genus of hardy, bulbous-rooted, herbaceous, magnificently-flowering, Mexican plants, of the iris order. The peacock species, *Tigridia pavonia*, called by Linnæus *Ferraria tigridia*, was introduced to Britain in 1796, and is well known to all amateur florists as one of the most gorgeous glories of the parterre. Its bulb is tunicated, and of smaller size than that of the common narcissuses; its leaves rise from the root-crown, and are lanceolate, channelled, erect, large, and of a bright green colour; its floral footstalks rise from among the leaves to the height of about 10 or 12 inches; and its flowers are as large as those of the largest irises or lilies, and display the most brilliant mixtures and spottings of orange and red, in the manner of the tiger's skin, and are so startling and superb as, at the very first glance, to astonish and delight even the most apathetic observers, and may be made to bloom in succession from May till September, but are individually among the most evanescent of sublunary grandeurs, and last each during only a part of one day, and scarcely unfold their magnificence to the sun or the breeze till they begin to wither and die. A variety called the lion-flower, *T. p. leona*, and a species called the shell-flowered tigridia, *T. conchiiflora*, were introduced in 1823; and the latter has a predominance of dark yellow in its corolla, and is scarcely less beautiful than the normal tiger-flower, yet does not display the same diversity and depth and brilliancy of tints. All the three kinds love a soil of sandy peat, and are propagated from offsets, and may be grown in clumps or beds of the open ground, in the same manner as any other hardy bulbous-rooted bloomers. The common treatment is to cut down the stems and take up the bulbs in autumn, and to replant the latter in a dried state in spring; but a much better one is to lift the plants in autumn with balls or masses of attached soil, to put them in pots of sufficient capacity to admit the attached balls, and to keep these in a cold pit till the time of replanting in spring.

TIGLIUM. See Croton.

TIGRIDIA. See Tiger-Flower.

TILE. A thin brick fabric, either flat, undulated, semi-cylindrical, tubular, or of any other form. Tiles of various kinds have, in recent times, come into very extensive use in georgy as materials of subsoil drains; and, in consequence, possess great interest to all persons who have any sort of connexion with agriculture,—and very eminently to farmers and landed proprietors. A

notice of the principal varieties hitherto used, as well as of their comparative merits, and of the methods of employing them, occurs in the last section of our article on DRAINING; and a further notice of the comparative merits of some of the best of these, as well as some hints on the processes of manufacturing them, may be proper in this place.

Three different kinds of tiles—one tiles and soles, another tiles and covers, and another pipe tiles, all prime of their respective classes, and each comprising several sizes or varieties—were prominently noticed about six years ago, in connexion with an award of silver medals by the Royal Agricultural Society of England to the Tweeddale Patent Tile and Brick Company of London for their hand-tile machine, invented by the Marquis of Tweeddale,—to Mr. Etheredge of Woodlands, near Southampton, for his new patent machine for making tiles and covers,—to Mr. John Read of London, for an invention of cylindrical or pipe tiles,—and to Messrs. Ransome of Ipswich, for a Beart's brick-machine, improved by Mr. A. Stickney of Ridgemont, Holderness. The dimensions, weight, and price of these various tiles were as follows:—

Kind of Tile.	Internal Dimensions.	Area.	Weight per thousand.	Length.	Weight per 1000 feet.	Lineal feet per ton.	Thickness of Material.	Price per thousand.	Price per 1000 feet.
	In. In.	Sq. In.	Lbs.	In.	Lbs.	Ft.	In	£. s. d.	£. s. d.
Tweeddale .	$2\frac{3}{4}$ by $2\frac{3}{4}$	6·75	5500 tiles and soles.	$14\frac{1}{4}$	4631	484	0·55	2 2 0	1 15 4
Etheredge .	$2\frac{3}{4}$ — $1\frac{3}{4}$	3·18	5376 ,, ,,	$14\frac{1}{4}$	4527	495	0·65		
,,	$2\frac{1}{2}$ — $1\frac{1}{2}$	3·18	5600 ,, and covers.	$14\frac{1}{4}$	4717	475	0·65	1 10 0	1 5 3
,,	$1\frac{1}{2}$ — $1\frac{1}{2}$	1·56	5152 ,, ,,	$14\frac{1}{4}$	4338	539	0·65		
,,	$1\frac{1}{2}$ — $1\frac{1}{2}$	1·56	4928 ,, and soles.	$14\frac{1}{4}$	4150	516	0·65		
Read, No. 1 .	2·25 diam.	3·97	2844 pipe.	12	2844	787	0·40	1 18 0	1 18 0
,, 2 .	2·00 ,,	3·14	2657 ,,	12	2657	843	0·40	1 14 0	1 14 0
,, 3 .	1·60 ,,	2·01	1937 ,,	12	1937	1156	0·35	1 9 0	1 9 0
,, 4 .	1·35 ,,	1·43	1313 ,,	12	1313	1706	0·35	1 5 0	1 5 0
,, 5 .	1·00 ,,	0·79	1032 ,,	12	1032	2170	0·25	1 1 0	1 1 0

The machine for making the Tweeddale tile is well known, and needs no description. Its advantages consist in economising the labour of making to a small extent, in giving a greater certainty to the quantity made, and in producing a better article than tiles of the same kind manufactured in the ordinary manner. The superior quality arises from the greater density given to the clay in passing through the machine than can be obtained by hand labour. The machine requires a man and a stout lad to work it, and two boys to carry the tiles to the drying shelves; and it is adequate, in a fair season, to the production of about 600,000 tiles, and as many soles. Its present price is £40; and it requires a pug-mill, and the usual appurtenances of a tilery.

Mr. Etheredge's machine consists in the adaptation of a series of dies of a peculiar form to the bottom of a pug-mill, through which the clay is expressed, and received on mandrils answering to the form of the die. The mill erected at his works at Eling, and substantially made by Messrs. Ransome, contains eight of these dies. It is driven by one horse at a time; and by changing the horse every three hours, the constant working of it can be satisfactorily performed by two blind but able horses. This machine is represented as capable of producing 1,000 tiles and as many soles or covers per hour; but it may, perhaps, be advisable to consider its average work in a season at 8,000 per day. The hands employed are one man to fill the mill,—two boys to cut off the pipes and place them on barrows,—one man and a boy to wheel away and set them to dry on frames, provincially termed hakes, covered with cloth, supported on iron standards, and two men, a boy, and a burner to fill the kiln, burn, and draw the tiles, the kiln holding 36,000. Much ingenuity has been exercised in the construction of the mill and dies. Two tiles and two soles or covers are comprised in each pipe extruded from the machine, which being nearly severed within in four vertical lines whilst passing through the die, breaks by the shrinkage consequent on drying into four parts. The form, dimensions, and substance of the tile may be varied from the perfect hollow cylinder, to the oval, horse-shoe, angular, or any other desirable figure. The price of the mill with eight dies is £43, and proportionally less or greater for smaller or larger machines; and the cost of an establishment will vary from £150 to £350, according to the number of tiles required to be made during a season.

The pipe-tile machine is of the simplest construction, and costs only about £6 or £7. It consists of a mere frame of wood, having a cross-bench or platform, upon which is placed an iron cylinder about 17 inches long, by $6\frac{3}{4}$ inches diameter, fitted with the mould or die at its bottom. Its capacity is about 608 cubic inches, which bulk of clay suffices for the production of 24 pipes of the smallest or No. 5 size. This cylinder, when filled with well-washed and pugged clay, is placed on the platform over a hole, and has an iron-ring on the top fitting the inside, upon which rests a wooden piston or plug attached to a cross-bar, which slides up and down in a groove formed in each upright of the frame. By means of a wooden axle connected by two short cords with the piston cross-bar, and a

handspike, the man forces down the piston, and expresses the clay through the die. The pipe is received by a boy on a stick, loosely fitting its bore, which also gauges the length of each pipe; and it is then cut off by a wire, placed on a hand-barrow, and carried to the adjoining drying-shed by another boy. One man and two boys make about 1,800 per day of the smallest sized pipe. It is requisite that the clay be well washed and sieved before pugging, for the manufacture of these tiles, or the operation of drawing them, would be greatly impeded by having to remove stones from the small space surrounding the die which determines the thickness of the pipe. But, it results from this necessary washing, that the substance of the pipe is uniformly and extremely dense, which consequently gives to it immense strength, and ensures a durability which cannot belong to a more porous though thicker tile. The clay is brought from the pug-mill so dry that, when squeezed through the machine, not a drop of water exudes; moisture is, indeed, scarcely apparent on the surface of the raw pipe. Hence, the tiles undergo little or no change of figure whilst drying, which takes place very rapidly by reason of their form and slight substance. They are placed in the kiln when containing only about 12 per cent. of moisture, in consequence of which there is but trifling loss in the burning; and each shrinks about 15 per cent. in its length between its raw state from the press and when burnt; yet these particulars will vary a little with the nature of the clay used. A manufactory of pipe-tiles may be added to any existing brick-field, at an expense of about £100, and for a less sum where kilns and pug-mills are in use. This estimate includes the machine with a single die, a pug-mill, washing apparatus, kiln, and drying-shed. The manufacture might be carried on throughout the winter by securing the raw pipes against frost. This would necessarily occasion some additional outlay, but it is thought would not enhance the cost of the tiles, as the hands would not lie idle. It is a consequence arising from the small dimensions and weight, together with the comparative dryness of the tile when produced, which properties diminish to a *minimum* the bulk of the material used, and the space required for manufacturing and drying. Such an establishment would suffice for the annual production of 540,000 tiles, which is equivalent to the annual drainage of about 240 acres of land, from 30 to 36 inches in depth, at a mean of about 20 feet between the drains, and at a cost not exceeding £3 per acre in clays and firm-bottomed soils, unencumbered with stones. Other important advantages attending the cylindric figure and light weight of the pipe-tiles, are the diminished cost of carriage, and the faculty of conveying them into the field by hand.

Time is the only criterion for forming a perfect estimate of the durability of such an article as the drain-tile; but density and toughness are acknowledged tests of good pottery; and it can scarcely be questioned that the densest tile will endure the longest in the ground. After a careful investigation of the solid contents and weights of the tiles registered in the table, the following facts appear as regards their density:—

	Weight. Oz.	
Tweeddale,	0·973	per cubic inch of matter.
Etheredge,	1·091	,,
Read, No. 1,	1·138	,,
,, 2,	1·174	,,
,, 3,	1·204	,,
,, 4,	1·322	,,
,, 5,	1·401	,,

These results seem to be in strict conformity with the degree of preparation of the earth, as well as with the nature and amount of the force to which the respective tiles are subjected in the apparatus employed; and it is seen that the density of the cylindric tile increases in the inverse ratio of the magnitude of the orifice through which the clay is expressed from the cylinder. It must, however, be borne in mind that, in order to render comparisons of this kind free from error, the clay of differently made tiles should be alike.

An establishment, with all requisite appurtenances, for making drain-tiles with Hatcher's machine—a considerably different one from any of those already glanced at—may be set up on any estate or farm at a cost of £25 for the machine, £10 for the pug-mill, £5 for the kiln, and £10 for the sheds and straw, or of £50 for the whole; and whenever the proprietor has made as many tiles as he wants for his own use, he may either continue the manufactory for the sale of tiles to others at a profit to himself, or sell his machine and his pug-mill at very nearly their original price. The machine, too, makes roofing-tiles of prime quality, at less than half the price of those made by hand, and of a much lighter, closer, and straighter character; and, in general, it highly recommends itself both by the simplicity of its construction, and by the small amount of hand-labour required to work it. All clay intended for use throughout any season must be dug as early as possible in winter, in order that it may undergo the most thorough exposure to the action of air and frost and snow. Care must be taken if there are small stones in it, to dig it in small spits, and cast out the stones as much as possible, and also to mix well the top and the bottom of the bed together. It is almost impossible to give minute directions as to mixing clay with loam, or with marl when necessary, for the better working of it afterwards, as the difference of the clays in purity and tenacity is such as to require distinct management in this respect in various localities. But all the clay dug for tile-making will require to be wheeled to the place where the pug-mill is to work it; and it must be there well turned and mixed in

the spring, and properly wetted, and finally spatted down and smoothed by the spade, and the whole heap well covered with litter to keep it moist and fit for use through the ensuing season. One man and three boys will turn out from Hatcher's machine nearly 11,000 pipe tiles of one-inch bore in a day of ten hours, and so in proportion for pipes of a larger diameter. This machine, also, has the great advantage of being moveable; and those who work it draw it along the shed in which the tiles are deposited for drying previously to their being burnt. Each tile, therefore, is handled only once,—for it is taken off the machine by the little boys, who stand on each side, and at once placed in the rows on either side of the drying shed; so that the use of shelves in the sheds is wholly unnecessary,—for the tiles soon acquire a solidity to bear row upon row till they reach the roof of the sheds on either side; and they dry without warping or losing their shape in any way. The pug-mill is necessary to ensure the due mixing of the clay, as well as to form it into the exact shape to fill the cylinders of the machine; and it must be worked by a horse; and in general one day's work at the mill will furnish rather more prepared clay than the machine will turn into tiles in two days. The only sheds necessary for drying the tiles are of a temporary kind, and may be made of ordinary farm-hurdles, without either diminishing their value or occasioning any serious inconvenience from their temporary appropriation. The sides of the sheds may be formed of strong hurdles pitched firmly in the ground in two parallel straight lines, 7 feet apart; and the roof may be formed of hurdles placed endways and tied together at the top, as well as to the upper slit of the hurdle, with strong tarred twine, forming the ridge of the roof exactly over the middle of the shed; and the hurdles must then be lightly thatched with straw or heath, and the sharpness of this roof will effectually protect the tiles from rain. Two of these sheds, each 110 feet long, will keep one kiln in full work; and they should be so built as to have one end close to the pug-mill and the clay-heap, only leaving just room for the horse to work the mill, and the other end near the kiln. The kiln is circular; 11 feet in diameter, and 7 feet high. It is wholly built of damp earth, rammed firmly together, and plastered inside and out with loam. The earth to form the walls is dug out round the base, leaving a circular trench about 4 feet wide and as many deep, into which the fire-holes of the kiln open. If wood be the fuel used, three fire-holes are sufficient; if coal, four will be needed. About 1,200 common bricks are wanted to build these fire-holes and flues. If coal is used, rather fewer bricks will be wanted, but then some iron bars are necessary—six bars to each fire-hole. The earthen walls are 4 feet thick at the floor of the kiln, and are 7 feet high, and taper to the thickness of 2 feet at the top; and this will determine the slope of the exterior face of the kiln. The inside of the wall is carried up perpendicularly, and the loam plastering inside becomes, after the first burning, like a brick wall. The kiln may be safely erected in March, or whenever the danger of injury from frost is over; and after the summer use of it, it must be protected by faggots or litter against the wet and the frost of winter. A kiln of these dimensions will contain 47,000 pipe tiles of 1 inch bore, 32,500 of $1\frac{1}{4}$ inch bore, 20,000 of $1\frac{3}{4}$ inch bore, or 12,000 of $2\frac{1}{4}$ inches bore, and the last-mentioned size will hold the same number of the inch pipes inside of them, making therefore 24,800 of both sizes. In good weather the kiln can be filled, burnt, and discharged once every fortnight; and 15 kilns may be obtained in a good season, producing—705,000 pipe tiles of 1 inch bore, 487,500 of $1\frac{1}{4}$ inch bore, or 300,000 of $1\frac{3}{4}$ inch bore; and so on in proportion for other sizes. If a kiln of larger diameter be built, there must be more fire-holes, and additional shed room. Prize Essays of somewhat detailed character, on the manufacture of drain-tiles in more extensive establishments or by more elaborate processes than we have described, occur in the 12th and 14th volumes of the Highland Society's Transactions.

TILE-DRAINING. See Draining.

TILE-ROOT, — botanically *Geissorhiza*. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. About a dozen species have been introduced to the greenhouses of Britain, varying in height from 6 to 20 inches, carrying either white, yellow, blue, violet, or variegated flowers, most blooming in the early or middle part of summer, and almost all loving a mixed soil of sand and peat and loam, and propagable from offsets.

TILIA. See Lime-Tree.

TILL. A hard, obdurate, retentive boulder-clay,—or a stiff, refractory, impervious, clayey subsoil, imbedding a considerable quantity of gravel, or interspersed with pebbly and bouldery water-worn stones. It is a variety of the drift or diluvium of geologists, and constitutes one of the most churlish subsoils of farmers. The word, however, is provincial, and probably has different shades of meaning in different districts.

TILLÆA. A small genus of curious herbaceous plants, of the crassulaceous order. The mossy species, *T. muscosa*, is an indigen of the barren sandy heaths of some parts of England. It is a minute succulent annual, of only an inch or two in height, and carries pellucid flowers from June till October.

TILLAGE. Breaking up, turning over, stirring, pulverizing, and otherwise working the soil preparatorily to the raising of crops from seeds, offsets, or other germs. The principal operations of it are ploughing, grubbing, harrowing, rolling, and horse-hoeing; and a very complete close

series of them occurs in summer-fallowing. See the articles Ploughing, Plough, Harrow, Grubber, Rolling, Roller, Hoeing, Horse-Hoe, Fallow, Pulverization, and Drill-Husbandry.

TILLANDSIA. A genus of ornamental, tropical, herbaceous plants, of the bromelia family. About 30 species have been introduced to British gardens from the tropical and subtropical regions of America; and about 20 more are known. Almost all are epiphytes, and naturally vegetate among the black mould which collects in hot moist countries upon the bark of trees; and some form dense festoons among the branches of trees, and in deep and gloomy forests. Those in British gardens vary in height from a few inches to 6 or 8 feet; most love a soil of sandy peat, and are propagated from suckers; the majority have blue flowers, and the rest either purple, pink, yellow, or white flowers; and a few bloom in autumn or the early part of winter, but most in June and July. Among the most beautiful or otherwise interesting are the moss-like, *T. usneoides*, purple-flowered, July-blooming, and commonly 6 or 8 feet high, introduced from the West Indies in 1823; the xiphium-like or sweet-smelling, *T. xiphioides*, white-flowered, July-blooming, and commonly about two spans high, introduced from Buenos Ayres in 1810; the strict, *T. stricta*, blue-flowered, either November-blooming or spring-blooming according to treatment, and commonly about 10 inches high, introduced from Brazil in 1810; the fair, *T. pulchra*, pink-flowered, November-blooming, and commonly about 10 inches high, introduced from Trinidad in 1823; the bulbous, *T. bulbosa*, blue-flowered, August-blooming, and commonly about 6 or 8 inches high, introduced from Trinidad in 1823; the bladdered, *T. utriculata*, pale-yellow-flowered, and commonly about 2 feet high, introduced from South America in 1793; and the flexuose, *T. flexuosa*, blue-flowered, June-blooming, commonly about a foot high, introduced from the West Indies in 1790, and comprising a yellow-flowered variety, *T. f. pallida*, introduced in 1815. Some of the species may be cultivated in the manner of air plants; and most require similar treatment, and make similar displays, to the epiphytous, tropical orchidaceæ. See the articles Air-Plants and Orchis. The strict species, while one of the most handsome, is one of the most easily cultivated, and forms a tempting subject to a beginner in tender, epiphytous floriculture. In June, it may be taken out of the stove, and suspended from a wall in the open air; from June till the decline of autumn, it should remain in this position without either protection, watering, or any other attention; in October, it will be found withered, discoloured, and seemingly half-dead, and must then be submitted to a full and regular course of house-protection, heat, and moisture; in a few weeks, it will lose all trace of its previous sufferings, and display a rich healthy vegetation; and, after throwing out suckers on each side, it will shoot up its spikes of bright blue flowers, and bloom from March till the end of April, and then harden and droop and become ripe for removal to the open air in June.

TILLERING. The branching of the culms of the cereal grasses or pulse plants from the root crown, or the rising of several shoots or stems from one seed. This depends partly on the constitutional proliferousness of species or varieties, partly on favourable circumstances of soil, situation, climate, and weather, and partly on the character of the tillage, the manner of sowing, the depth of the seed, and the aggregate circumstances of the husbandry; and, in a general view, it occurs vastly oftener and far more powerfully under the most improved methods of drill-culture than under the old slovenly methods of broadcast culture.

TILLS. Common cultivated vetches.

TILTH. The condition into which the soil is worked by tillage, or the fitness which it possesses for the incorporation of manure and the reception of seed.

TIMBER. The wood or solid substance of the stems and branches of shrubs and trees. The name is applied loosely and popularly to all felled or cut wood which can be used for fuel, paling, or any ordinary purpose of art or economy, and strictly and technically to wood of at least 8 inches in diameter or 2 feet in circumference, such as can be employed in some department of carpentry. A plant which furnishes timber in the former sense may be only a shrub or a sapling, while that which furnishes it in the latter sense must be a tree; and a great tract of the former may be only a thicket or a coppice, while a great tract of the latter must be a forest. The heart-wood or main body of timber is noticed in the article Duramen; the sap-wood or soft exterior layer, in the article Alburnum; the sheath which envelopes and protects the whole, in the article Bark; the cultivation and management of the plants which yield it, in the articles Forests, Plantation, Planting, Pruning, Felling, Coppice, Barking, Tree, Wood, Dry-Rot, Kyanizing, Oak, Elm, and a multitude of others; and some of the most interesting facts and phenomena connected with the natural history of these plants, in the articles Age of Plants, Absorption of Plants, Ascent of Sap, Cambium, Cellular Tissue, Lignin, Ashes, Resin, Canker, and many others.

The entire substance of timber, exclusive of water and of gummy, resinous, oleaginous, saline, and extractive secretions, consists of cellular tissue and of woody fibre,—the former constituting its tissue, and the latter constituting its filling-up or main-bulk. "The distinction between these two elements of wood," says M. Boussingault, "was first made by M. Mohl; but M. Payen was the first who fixed the opinion of chemists and of vegetable physiologists

upon their true nature. By treating the vegetable tissue in its nascent and still gelatinous state—as in the unimpregnated kernel of the almond or of the apricot, in the membranous matter of the cambium of the cucumber, in the spongioles of radicles, and in leaves, wood, and other substances—with different menstrua, M. Payen obtained the cellular tissue in the state of purity, and having an elementary composition almost identical, from whatever source derived; and this latter fact may be seen from the following table, which gives the composition of cellular tissue from different sources, after having been dried at 352° Fahr.

	Carbon.	Hydrogen.	Oxygen.
Ovules of the almond tree,	43·6	6·1	50·3
„ of the apple and pear,	44·7	6·1	49·2
„ of the helianthus annuus,	44·1	6·2	49·7
Pith of the elder,	43·4	6·0	50·6
Cotton,	44·4	6·1	49·5
Endive,	43·4	6·1	50·5
Banana,	43·2	6·5	50·3
Leaves of the agave,	44·7	6·4	48·9
Cotton of the Virginian poplar,	44·1	6·5	49·4
Heart of oak,	44·5	6·0	49·5
Pine tree,	44·4	7·0	48·6
Perisperm of the phytelaphas,	44·1	6·3	49·6
Mushroom,	44·5	6·7	48·8

The primary tissue, consequently, which constitutes the skeleton of wood, is still isomeric or identical in elementary composition with starch. With mineral acids the cellular tissue further undergoes changes which assimilate it with starch; for on treating it with sulphuric acid, it is changed into dextrine and sugar. Woody fibre, or pure wood, or woody tissue, as it has hitherto been obtained after the action of solvents, and been examined by preceding chemists, differs considerably in composition from the cellular tissue, and consists of the following proportions of elements:—

	Carbon.	Hydrogen.	Oxygen.	Authorities.
Woody tissue of the oak	41·8	5·7	52·5	{Gay Lussac & Thenard.
„ of the beech	42·7	5·8	51·5	Do.
„ of the box	44·4	5·6	50·0	Prout.
„ of the willow	44·6	5·6	49·8	„
„ of the oak	49·7	6·0	44·3	„
„ of the beech	44·3	6·0	49·7	Payen.
„ of the aspen	44·5	6·1	49·4	„
Wood in the natural state:	45·6	6·4	48·0	„
„ of the oak	39·4	6.2	54·4	„
„ of the beech	39·3	6·3	54 4	„
„ of the herminiera	46·9	5·3	47·2	„

From these analyses it appears that wood in the natural state contains more carbon than woody tissue obtained in the way of purification, and that this latter substance is also richer in carbon than the cellular tissue which necessarily forms part of it. In the purified woody tissue, therefore, the cellular tissue is associated with the principle which fills its cells, or which encrusts it,—and it is to this matter that M. Payen has applied the name of encrusting matter; it is wood properly so called; it is that which gives to timber its hardness, its tenacity; it predominates in hard wood and in knots; it corresponds with the duramen of physiologists; it constitutes almost the whole of the hard particles which are met with in woody pears and in cork, and which are hard enough to blunt well-tempered steel instruments. As this incrusting matter is friable in many instances, it may be pulverized and separated from the tissue which surrounds it, this last tearing or yielding in shreds under the pestle. By means of the sieve, the incrusting matter may, in this simple way, be obtained nearly in a state of purity. The analysis of M. Payen shows it to consist of 53·8 per cent. of carbon, 6 of hydrogen, and 40·2 of oxygen."

Timber greatly varies in properties and adaptations, according to the comparative density, resinousness, and other constitutional qualities of the different genera and species of trees; and though in every instance more dense than water, and capable of sinking in the form of either sawdust or dried chips or thoroughly exsiccated billets, it, in most instances, floats in consequence of containing a large quantity of air within its pores. The specific gravity of the white woods, such as those of willow and pine, is about 1·46; that of the heaviest woods, such as those of oak and beech, is about 1·53; and that of a few of the most remarkable species, or of their most remarkable parts, is as follows:—

Pomegranate	1·35
Guaiac, Ebony	1·33
Box	1·32
Oak of 60 years old, the heart	1·17
Medlar	0·94
Olive	0·92
Spanish Mulberry	0·89
Beech	0·85
Ash	0·84
Hornbeam	0·80
Yew	0·80
Apple	0·79
Plum	0·78
Maple	0·75
Cherry	0·75
Orange	0·70
Quince	0·70
Elm, the trunk	0·67
Walnut	0·67
Pear	0·66
Spanish Cypress	0·64
Lime	0·60
Hazel	0·60
Willow	0·58
Arbor Vitæ	0·56
Pine	0·55
Spanish white Poplar	0·52
Pine	0·49
Poplar	0·38
Cork	0·24

The specific gravity of every species, however, is very observably affected by at once age, climate and soil. All timber, when newly cut down, contains a considerable quantity of water. One hundred parts of walnut-tree, dried at 212° Fah-

renheit, lost 37·5 parts by weight; of white oak, 41 parts; of maple, 48. On an average, the quantity of water contained in green wood may be estimated at about 40 per cent.; and the quantity lost by drying or seasoning during eight or ten months, will not amount to more than about 25 per cent. The timber which is used for burning almost always contains about a quarter of its weight of moisture, which not only does not assist in producing heat, but actually absorbs a great deal, to effect conversion into vapour. The composition of woody matter may be represented, on the average, as comprising 52 per cent. of carbon, and 48 per cent. of hydrogen and oxygen, in the proportions which form water; so that the definitive products of its combustion ought to be carbonic acid and water. The heat disengaged during its combustion, necessarily proceeds from the union of its elements with the oxygen of the atmosphere; but, the hydrogen being already present with the proportion of oxygen required for its combustion, may be regarded as already burned, and therefore the heat produced by the wood depends solely on the quantity of carbon which it contains.

The calorific or heat-yielding power of any one kind of wood, used as fuel, suffers deduction correspondingly to the degree of moisture which is present in burning, and can be realized with little of this deduction only when the wood has been dried in stoves or otherwise rendered as dry as possible; and the calorific power of different species, all in the same or similar states, is considerably controlled, not only by their proportional amount of carbon, but by their comparative density, and by the peculiar character of their resinous, saline, and other specific secretions, and, probably on account of conflicting methods of testing or determining it, has been represented by some experimentalists as always essentially different, and by others as virtually or eventually uniform. Assuming that the quantity of heat be designated as unity which is requisite to raise one kilogramme of water one degree of the centigrade thermometer, or 2·2 lb. of water 1° 8′ of Fahrenheit, the following table, by Rumford, shows the calorific power of one kilogramme of each of fourteen kinds of fire-wood, in the several conditions which it specifies; so that one kilogramme of dry lime-tree will raise 3,460 kilogrammes of water one degree of the centigrade thermometer, or 2·2 lb. of it will raise 7,612 lbs. of water 1° 8′ of Fahrenheit's thermometer,—and so of the other instances.

Kinds of wood.	Units of heat evolved.
Lime-tree dry	3460
The same thoroughly stove dried	3960
Beech dry, four years seasoned	3375
The same well dried in a stove	3630
Elm, from four to five years seasoned	3037
Oak, fire-wood	3550
Ash, dry	3075
Wild cherry	3375
Fir, dry	3037
The same well dried in a stove	3750
Poplar, seasoned	3450
The same well dried in a stove	3712
Hornbeam	3187
Oak, dry	3300

From the experiments of Clement, it appears that the heating power of charcoal is equal to 7,050 units; and as dry wood contains 52 per cent. of charcoal, its heating power has been deduced theoretically, as equal to 3,666. Mr. Marcus Bull in America, made a series of experiments to determine the relative quantities of heat given out by different kinds of wood; and from these M. Peclet concludes that the same weight of dry wood of every kind has the same heating power, and that this for a kilogramme, or 2·2 lbs. avoird. of wood dried by artificial means, is equal to 3,500 units, whilst the same quantity of the same wood which has been cut and seasoned during from 10 to 12 months, and which contain from 20 to 25 per cent. of water, is no higher than about 260 units. But though the same quantities of wood, brought to the same degree of dryness, appear to have the same absolute calorific power, all are not alike adapted to the same purposes. Hard woods, for example, burn slowly, and give out less heat in a certain time than the less compact kinds of wood; and hence fir is preferred to oak in furnaces where the object is to obtain the most intense heats.

The different species of trees may be distinguished from one another, and are powerfully modified in their adaptations to the arts, by the size and arrangement of their cellular tissue. One series of white and shining laminæ, called by botanists the medullary rays and by carpenters and other workers in wood the silver grain, radiates from the pith to the bark; and another series of minute cells, called by botanists the concentric layers and by workers in wood the spurious grain, is disposed in circular lines or groups at successive distances around all the intermediate space between the pith and the bark; and both series, when examined in thin horizontal slices of the timber, through a common four-power microscope, are seen to have a different arrangement, and to comprise different sizes of cells or grains, in the different species of wood. The characters of these series, in a few of the most common and diverse kinds of home-grown timber, may be advantageously studied by practical men; and shall here be copied, with slight condensation, from the Useful Knowledge Society's Treatise on Planting, where illustrative diagrams of them may be seen.—The elm has the medullary rays, or silver grain, equal and not crowded. The concentric layers are composed of a series of cells of nearly unequal diameter, arranged in an almost simple curved line. The spaces between the layers are furnished with cells of a smaller diameter, and rather thinly scattered over the surface.—The oak has two

series of medullary rays; the primary ones are large and strongly marked, distant from each other, and are uninterrupted in their course from the pith to the bark; the secondary rays are numerous between the primary, but not crowded. The concentric layers, or circles, are distinguished by the arrangement of the cells; they are grouped in somewhat triangular masses, forming a wavy circular outline. The structure of the concentric layers or annual rings, distinguishes at once with certainty the wood of the oak from that of the chestnut, with which it has often been confounded.—The ash has the places of those rays so prominent on the wood of the oak, supplied by twin rays placed in wide intervals over the surface; and between these double rays are smaller ones, placed in regular order. In the narrow spaces between the individuals which constitute the twin rays are wanting those apparent remains of the cellular texture which are so remarkable in the spaces between the single rays.—The beech has the primary rays dispersed pretty regularly over the surface of a horizontal section of the wood; the secondary rays are not continuous from the pith to the bark, but interrupted, and exhibit a numerous series of fragments of rays, filling up the spaces between the primary ones, obvious to the naked eye, and rendering the silver grain very distinct from that of any other kind of wood.—The Spanish or sweet chestnut agrees with the oak in having the secondary rays equally disposed, almost straight, and, though close to each other, yet not crowded as in the elm and the beech; but it differs, in the primary rays being scarcely to be distinguished from the secondary, whilst in the oak these are prominent and obvious to the naked eye on the slightest inspection,—in the concentric layers being regularly curved, whilst in the oak they are strikingly waved,—and in the mouths of the tubular vessels, which constitute so obvious a part of these annual rings or layers, being in regular order, while in the oak they are disposed in triangular masses.—The hornbeam has the rays nearly equal, but may readily be distinguished from the beech, to which it bears the greatest resemblance, by the simple arrangement of the tubular structure accompanying the concentric layers, which in the hornbeam are distant and oval-shaped, the narrow sides pointing to the pith and to the bark, while in the beech they are circular-shaped, more numerous, and equal-sized.—The birch has all the medullary rays nearly equal, arranged closely, and the concentric circles minute, but marked with a row of equal cells.—The horse chestnut has all the rays very minute, few of them apparently continuous, but interrupted, and in substance varying in breadth. The cells are numerous and minute.—The alder has large primary rays, thinly arranged, but in nearly regular order, and the secondary rays slender, numerous, and interrupted. The cells of the concentric layers are nearly regular. The spaces between the rays are crowded with cells.—The oriental plane has the primary rays regular but closely arranged, and somewhat wavy, and the cellular texture of the concentric layers but slightly marked.—The sycamore in texture approximates to the plane, yet is very distinct in its straight lined rays, which are very minute or slender. The cellular texture is composed of such minute cells as scarcely to be perceptible under a four-power microscope; these cells are, however, very numerous.—The poplar has the wood composed of rays so slender as not to be obvious to the naked eye. The concentric layers are composed of exceedingly minute cells. This wood is extremely porous; the cells of which it is composed are so numerous that a very thin slice of the wood, taken horizontally, exhibits the appearance of the finest possible open network.—The common acacia, or locust, bears some resemblance to the oak; but it wants the distinct primary rays so prominent in the oak, and has its rays nearly all of equal breadth, and as slender as the secondary rays of the oak, and somewhat wavy. The cellular or tubular structure is also very different from that of the oak, the cells being arranged in more regular order where they mark the concentric layers; and the spaces between the rays are furnished with many cells irregularly scattered over, of a size equal to those marking the concentric layers.—The fir is distinguished by very prominent coloured concentric layers, arranged very regularly throughout; and the cellular texture, though composed of cells sufficiently large to be seen with the naked eye, is not to be distinguished without very close observation.—The lime has very slender equal rays, and a minute cellular texture pervading the whole body of the wood. The concentric layers are scarcely perceptible to the naked eye. It may be compared to the poplar; but the network-like arrangement of the cellular texture is not so obvious; and the presence of the rays readily distinguishes it.—The laburnum is distinguished by its minute, regular, uninterrupted medullary rays, and by the broken beaded longitudinal lines of the tubular structure.

Timber trees are conveniently classified, by practical men, into foreign and domestic, or such as will not and such as will grow and prosper in the plantations of Britain; and the latter may be subclassified into deciduous hardwood trees, deciduous aquatic trees, larches, and evergreen trees. Foreign timber-trees yield most of the fancy woods used in cabinet work and for fine or small ornamental purposes; and some of them, notwithstanding their rare beauty and reputed scarceness, attain a great size in the natural forests of the tropics; and among these are the mahogany tree, which sometimes acquires a diameter of upwards of 6 feet,—the wood of St. Martha, which is very hard, and has a deeper colour and a more beautiful appearance than mahogany, and sometimes attains a diameter of

nearly 4½ feet,—the *Cedrela odorata*, which emits an aromatic fragrance, and is never attacked by insects, and sometimes attains a height of 150 feet and a diameter of 6½ feet,—the *Bombax pentandrum*, which, at even 60 years of age, has been known to have a girth of 26¼ feet, and to spread its boughs over a circular area of 120 feet in diameter,—the Zamang, a species of mimosa, which has been known to have a girth of 29 feet, and to spread its boughs over a circular area of about 204 feet in diameter,—and the *Hymenæa courbaril*, which, though as hard as mahogany, and in as great request among cabinet-makers and inlayers, sometimes attains the enormous diameter of 19 feet. The principal deciduous hardwood trees grown in British plantations are the oak, the elm, the ash, the sycamore or plane, the beech, the hornbeam, the Spanish chestnut, the horse chestnut, the walnut, the wild cherry, the maple, the lime, the laburnum, the hawthorn, and the mountain ash; the principal deciduous aquatic trees are the birch, the alder, the abele, the aspen, the black poplar, the Lombardy poplar, the elder, the willow, and the hazel; the only deciduous coniferous tree is the larch; and the principal evergreen trees, whether coniferous or otherwise, are the Scotch pine, the Weymouth pine, the black Austrian pine, the spruce, the common silver fir, the cedar of Lebanon, the yew, the holly, and the box. The peculiar properties and economical adaptations of the several kinds of timber are, in most instances, fully stated in the articles on the several genera or species.

All timber, when in a recently felled state, contains a large proportion of water, and is liable to shrinking, cracking, and eremacausis; and, before it can be profitably or wisely used for almost any purpose in the arts, it requires to be protected against these evils by a process of seasoning. This process, when left wholly or principally to the operation of natural causes, consists merely in the evaporation of the contained moisture of the timber into the atmosphere, and is at first comparatively rapid, and afterwards comparatively slow, and at all times accelerated or retarded by varying degrees of exterior heat and humidity; and, when duly favoured by such a position of the timber as exposes all its sides uniformly and equably to the evaporating action, it either renders the timber perfectly proof against all change dependent in any way on moisture, or permits it to be affected only by prolonged and constant wetness or by the mere hygrometric state of the atmosphere. The removing of the bark twelve months before felling, has been tried as a a method of seasoning oak and larch and perhaps some other species; but, at some seasons, if not in all, it will be found rather to soften the alburnum than to harden it. The subjecting of cut and sawn timber to a strong heat by means of steam has been still more extensively tried; and is regarded, in some departments, as a rapid, economical, and efficient substitute for the tedious method of natural seasoning, but has been abandoned in others as unsuitable or as too expensive. The immersion of logs in water, during a year or two previous to the process of natural drying, has been extensively tried in other departments, and is believed to dissolve out certain deliquescent salts, to bring the timber into the completest possible state of seasoning, and, not only to prevent it from shrinking and decomposing, but to fortify it against the erosions of insects and fungi. "In warm countries especially, it is advantageous to sink fresh-cut timber in water, with a view to prevent it from splitting, apparently in consequence of drying too quickly. The old Venetians sank, for a season in the sea, the oak timber which was destined for the construction of their gallies. Elm and beech, in particular, are said to improve greatly by the process of submersion in salt water, and to dry afterwards perfectly by simple exposure to the air. Mr. John Knowles, who made a particular study of the means most generally employed in seasoning timber, has given an account of a series of experiments undertaken in the arsenals of Deptford and Woolwich, to determine the rate of drying and ultimate degree of dryness attained by timber variously treated,—unprepared and prepared by previous submersion in water. The pieces of timber were placed vertically, now in the position they had occupied in growing, now in that opposed to this; and it was found that, circumstances the same, they dried more quickly in the former than in the latter. The general results of these experiments were, that the pieces of timber were best seasoned by being kept about thirty months in the air, but in the shade and protected from wet,—and that they lost more of their original weight after six months' alternate immersions and dryings, than by being kept under water for six months and then dried. Ship-builders are generally agreed that it is not expedient to make use of timber until three years after it is cut."

Three principal causes produce decay in felled or dead timber, seasoned or unseasoned,—and these are the action of eremacausis, the feeding of insects, and the growth of fungi; and all require the conditions of sufficient warmth, sufficient moisture, and stagnant air in order to their coming into play. The first is a slow and imperceptible combustion, of great power, explained in the article Eremacausis; and the second and the third, though seeming at first sight to be trivial, really possess overwhelming energy, and can speedily reduce the stoutest timber to a mass of mere dust. The rapidity with which wood is, in some circumstances, devoured by insects is almost incredible. Some years ago the thermites, or white ants, spread in such strength through the docks and arsenals of Rochelle and Rochefort, that in a very short space of time serious damage was done. A learned entomologist, M. Audouin,

commissioned by the French ministry to take information on the subject, reported that the ravages committed by these insects had been very considerable. But it is principally in warmer climates, where the temperature is steady throughout the year, and where there is no winter, that the thermites occasion the most alarming injury. At Popayan, for example, it is difficult to meet in a building, even of recent construction, with a piece of wood which is not gnawed and ant-eaten. The hardest and most compact woods do not always resist the attacks of these insects, which, farther, do not spare every kind of odorous wood, cedar for instance. —The dry-rot, which results from the development and growth of cryptogamic plants upon wood, is the curse of navies. Mr. Knowles is of opinion that this disease of timber has been known from the most remote antiquity; he believes that he can even recognise dry-rot in the sore called house-leprosy, mentioned in the 14th chapter of Leviticus. A ship attacked by dry-rot, becomes in a very short space of time unfit for sea. The Foudroyant of 80 guns is often quoted as an instance of its destructive powers; launched in 1798, she had to be taken into dock and almost rebuilt so soon as 1802. The fungi which induce dry-rot have been studied by Sowerby. Mr. Knowles signalizes two species in particular; one of which he describes under the name of *Xylostroma giganteum*, the other under that of *Boletus lacrymans*. The xylostroma does not extend beyond the part where it is developed; but the boletus, on the contrary, is propagated with frightful rapidity, and disorganises deeply and to a great distance around the texture of the wood where it once appears. These fungi are generally found on board ship, between the planking and the ribs, in damp situations, and where the air is scarcely, if ever, changed. See the articles Bostrichidæ, Dry-Rot, and Fungi.

The preservation of timber is a problem of eminent importance to vast multitudes of practical men, and involves great elements of national prosperity, and has been a subject of grave and varied investigation on the part of many distinguished philosophers. One remarkable method, resulting from modern invention, is noticed in our article Kyanizing; and another, that of M. Boucherie, professing to protect timber against both dry-rot and the ordinary wet-rot, to increase its hardness and strength, to preserve its flexibility and elasticity, to counteract its alternate contraction and expansion under varying conditions of the atmosphere, to diminish its inflammability and combustibility, and to give it a variety of permanent colours and odours—may here be explained, historically and descriptively, in the words of Boussingault—"In the whole of his experiments, M. Boucherie set out from this proposition, the truth of which appears indisputable and to require no comment, viz.: That all the changes which wood undergoes proceed or depend upon the soluble matters which it contains. In conformity with this idea, the first step towards giving durability to timber was, either to render these matters insoluble and inert, or to remove them entirely. M. Boucherie, therefore, in his first trials sought to render the matters insoluble by charging the wood with a substance capable of combining chemically and forming a precipitate with the soluble matter left by the sap. To resolve this problem, M. Boucherie investigated the reactions between the soluble matter of wood, which it was his object to precipitate, and a variety of low-priced chemical agents. He found that the pyrolignite of iron combined the greatest number of desirable properties; it is very cheap, the oxide of iron forms stable compounds with the greatest number of the organic substances which are found in the sap of vegetables, and to conclude, the crude pyrolignite contains a notable quantity of creosote. The facts upon which M. Boucherie relies as proving the preservative powers of the pyrolignite of iron flow from numerous experiments performed either on vegetable substances which in themselves readily and rapidly undergo changes, or upon billets of wood of different kinds. A quantity of flour, the pulp of carrots, beet-roots, &c., impregnated with the pyrolignite resist decomposition in a very remarkable manner in contrast with the same substances when they have not been prepared in any way. The wood which was selected for trial, was generally of the most perishable kind. In December 1838, several empty hogsheads and barrels made of the best timber, unimpregnated and impregnated with the pyrolignite, were placed together in the dampest parts of the great cellars of Bourdeaux. In August 1839, it was easy to see that the unimpregnated tubs were already deeply stricken, and after from two to three years they fell to pieces with the slightest force; the casks made of the prepared wood, however, were as sound as on the first day of the experiment. M. Boucherie concluded from his experiments instituted with a view to the settlement of the question, that about $\frac{1}{10}$th of the weight of the wood in its green state of the pyrolignite was adequate to precipitate and render insoluble all the principles obnoxious to change, which were contained in the woody tissue. M. Boucherie, whilst he regards the pyrolignite of iron as at once the most powerful and one of the cheapest preservatives of timber, nevertheless indicates several soluble salts, which are readily available in consequence of their low price, and also very effectual when the wood, which they are to preserve, is not kept constantly wet. Solutions of common salt, of chloride of lime, the mother-water of salt-marshes, &c., were all tried and found useful. Casks, the wood of which had been prepared with the chlorides, after having been long kept in very damp cellars, came out as fresh as those which had

been impregnated with the pyrolignite of iron; the flexibility of the wood preserved with these alkaline and earthy salts was farther as great as at the beginning of the experiment.

"Having now come to a conclusion in regard to the substances most effectual in preserving wood, the next business was to make them penetrate its tissue most intimately. Maceration, M. Boucherie soon found, like his predecessors in the same path, to be insufficient, the substances in solution only penetrating a very little way. He then tried various processes of injection; but all inferior to that imagined by M. Breant, and therefore less effectual. He then bethought him of effecting the needful penetration of the wood in the green state, and before it had been sensibly altered by drying and seasoning; he asked himself if the force which determines the ascent of the sap might not be taken advantage of after the tree was cut down, as a means of determining the entrance of a solution of pyrolignite of iron? And all his trials in this direction answered his expectations fully. M. Boucherie had, in fact, discovered a means of securing the penetration of the minutest pores of the largest log by a substance capable of rendering it incorruptible. No one before M. Boucherie thought of taking advantage of an admitted physiological fact for such a purpose. He announces the principle upon which he proceeds in these terms: 'If a tall tree be cut down at the proper season, and the bottom of the trunk be then immersed in a saline solution, weak or strong, the liquid is powerfully drawn up into the tree, penetrates its most intimate tissues, rises to its smallest branches and even to its terminal leaves.' In the month of September, a poplar, upwards of 90 feet high and nearly 16 inches in diameter, was cut, and the bottom of its bole plunged in a vessel, containing a solution of pyrolignite of iron marking 8° of the areometer of Beaumé; in the course of six days, it had absorbed upwards of 66 gallons of the fluid. In his first experiments, M. Boucherie procured the needful absorption by placing the bottoms of his trees in vessels containing the solution; but this mode of proceeding was obviously full of difficulties and open to many objections. The weight of a green tree of large size, with the whole of its top and branches is often enormous, and to raise a mass of the kind once down again into the perpendicular was no easy task; it implied recurrence to certain mechanical means which are not always at hand, and necessarily expensive. M. Boucherie, therefore, tried other modes of making the trees absorb; he adapted a sac of impermeable material to the bottom of the trunk laid on the ground, and into this sac he poured his solution, and this method answered very well. He next took advantage of one or more of the roots to effect the imbibition. He next bored a hole into the bottom of the trunk, still erect; and having brought the cavity thus made to communicate with a reservoir, he still succeeded. This last plan was still farther simplified in proceeding as follows: the trunk of the tree is pierced by an auger through nearly the whole diameter. Into the auger-hole thus made, a narrow saw is passed, by working which on either side, the trunk is divided internally to a very considerable extent, and the majority of its sap vessels are thus cut across and made accessible. An impervious cloth is then tied round the trunk, below the opening, and this is made to communicate with the reservoir of liquid.—M. Boucherie was almost necessarily led, in the course of his experiments, to inquire whether the absorbing power of trees differed at different seasons or not. He ascertained by trials made in the months of December and February, that though in the oak, the hornbeam, and the plane, the solution of pyrolignite of iron always rises several feet and even several yards, yet that in the colder season of the year, it never rises so high as it does in summer, in spring, and especially in autumn, the season in which the power of ascent is most remarkable. This conclusion is obviously of interest physiologically. It proves that if winter be a season of repose for the sap, it is not so absolutely. There is one remarkable exception to the general fact now announced, and this occurs among the resinous trees that keep their leaves till the spring. It has been ascertained, by direct experiment, that the ascent of the sap continues through the whole course of the winter in the cone-bearing trees, and this to such an extent, that it is always possible to impregnate every part of their trunk by the way of simple absorption at any period of the year. As M. Boucherie remarks, this fact might even have been foreseen from the fresh and green state of the leaves of these trees.—It now became important, in connexion with the practical application of M. Boucherie's views, to ascertain whether or not the penetration was energetic in the ratio of the vigour of the tree itself, in proportion as it was more numerously provided with branches, more thickly covered with leaves. Experiment showed that the penetration still takes place after the removal of the greater number of branches, provided only the leading bough or terminal crown be left. A stem furnished with a number of leafy branches continues, as has been said, to imbibe, though separated from the roots; but for how long a time will it continue to do so? This was a capital point to determine. At the end of September, the bottom of a pine tree about 14 inches in diameter was first put into the solution 48 hours after it had been felled; nevertheless the imbibition was complete. In June, the same success attended the experiment made on a plane that had been cut for thirty-six hours. Still it is certain that the penetration takes place with so much the more energy as it is arranged close upon the time of

the felling. The power by which it is determined declines rapidly after the first day is passed, and by the tenth day it is almost entirely gone. In favourable circumstances these ten days suffice to effect the complete impregnation of the largest stem. In one of his experiments upon a poplar, M. Boucherie saw the absorbed liquid reach the height of about 95 feet in seven days.—In the white woods, it is found that there is an axis of variable diameter in different cases which escapes or rather which resists impregnation. In hard woods, the parts which are not penetrated are the inner or undermost circles of the heart. M. Boucherie, after having ascertained these facts, explains them thus: in the white woods, according to the testimony of the workmen, the central part which resists the penetration is at once the weakest and the most perishable portion of the log; there is no longer any circulation, any life there; it is dead wood interred in the midst of the living woody layers. This absence of penetration of the woody tissue appears on some occasions elsewhere than in the centre of the trunk and branches; it presents itself under the most various forms and in different parts of the trunk; it appears to depend, as has been said, on the presence of wood abstracted from the influence of vital phenomena, and which, impenetrable itself, presents a barrier or an obstacle to the passage of the solution to other parts; it is thus that a knot, or a piece of rotten wood, is generally found as the starting point of the zones that have escaped imbibition. As to the non-penetration of the most central parts of the heart of oak, elm, &c., M. Boucherie views it as affording unquestionable proof of the fact that there the living juices of the tree had long ceased to circulate.

"The distinction generally drawn between the white or soft, and the perfect or hard wood, rests on the differences of colour presented by a transverse section of the trunk. In the oak, for example, the external and nearly white concentric layers are held as the soft and valueless portion of the log, and are commonly hewn away in squaring it; the darker more central portions constitute the heart-wood, the valuable timber. But according to M. Boucherie, the distinction is different when the fact of penetrability is taken as the guide, and all that portion of the trunk which imbibes is considered as alburnum or soft wood, and all that does not imbibe is regarded as hard wood. The alburnum in this way is so much extended that it may be found constituting three-fourths of the whole mass of the trunk. Once introduced, the pyrolignite of iron, according to M. Boucherie, is not only useful in preserving the wood, it also increases the density of the timber. Impregnated with this salt of iron, wood becomes so hard as powerfully to resist the tools of the carpenter and joiner, who even complain of the increased difficulty with which it is worked.—Flexibility and elasticity in timber are qualities in request for certain purposes, particularly for ship-building. The fir timber of the north of Europe is much more prized than that of the south, especially for masting, on account of its greater flexibility and elasticity, qualities which appear to depend in a great measure on the quantity of moisture retained; to increase these qualities M. Boucherie has even introduced by imbibition a deliquescent salt, such as the muriate of lime, which retains moisture powerfully as is well known, and seems to have the power of giving a remarkable degree of suppleness to wood. The experiments, contrived to show the effects of deliquescent salts were made upon deal, which is allowed to be one of the most brittle woods. After having impregnated it with concentrated solutions it was sawed into very thin veneers, some of which I have seen in the possession of M. Boucherie, which after being strongly twisted and bent in various senses, immediately regained their original flatness and evenness when they were left free.—Warping or shrinking is occasioned by alternate shrinking and swelling in consequence of varying hygrometric states of the atmosphere. After having found that this did not begin to take place until the timber was upon the point of losing the last third of the moisture which it contained at the time of being cut, M. Boucherie thought that to prevent all warping and shrinking it would be enough to retain this quantity of water in combination with the woody tissue, in other words, to prevent complete desiccation. Facts have proved the correctness of this view. Pieces of wood kept at a certain unchanging degree of moistness by means of a deliquescent salt infused into their pores, do not change their bulk or form, in spite of extreme variations in the hygrometric state of the air. Such pieces of wood, however, exhibit great differences in point of weight under the influence of different circumstances. Several planks of great breadth and extremely thin were prepared with chloride of lime and joined together; some of them were left unpainted, others were painted on one side, or on both sides; after the lapse of a year these planks were found not to have shrunk or warped, whilst similar planks of the same thickness and kind of wood, but unprepared, were found to have cast in an extraordinary way.—M. Boucherie has done more than this: he has not only had it in view to preserve wood and to prevent it from warping, qualities so desirable, he has made use of the same faculty of imbibition to impregnate the wood with a variety of beautiful colours, and thus to give even the most common kinds tints that will admit of their being used in the construction of costly furniture. The pyrolignite of iron alone gives an agreeable brown tint that harmonizes excellently with the natural colour of the harder parts of so many trees which usually resist penetration. By fol-

lowing up the pyrolignite with an infusion of nutgalls or oak-bark, the mass of the wood is penetrated with ink, which presents a black, blue, or grey colour, according to circumstances; a solution of another salt of iron succeeded by one of prussiate of potash will cause a precipitate of prussian blue in the wood, &c.; in short, by the numerous reactions of this kind with which chemistry is familiar, a great variety of colours may be obtained.—Among the number of useful properties communicated to wood by impregnation with saline solutions, that of being rendered little apt to combustion ought not to be omitted. M. Gay-Lussac was the first who thought of rendering vegetable tissues incombustible by means of saline impregnations. By incombustible, we are not to understand unalterable by a red heat; for every one must see that the protecting power of no salt can extend so far as this; but tissues which take fire very readily, and burn with great rapidity, cease from giving any flame and merely smoulder after they have been impregnated with certain salts; they take fire with difficulty, go out of themselves, become charred, and are incapable of propagating fire. And this is exactly what happens with wood which has been properly charged: it burns, and is reduced to ashes with extreme slowness, so that two huts exactly alike, built one of charged wood, and the other of ordinary wood, having been set fire to at the same moment, the latter was already burned to the ground, when the interior of the former was scarcely charred.

"The ingenious process of impregnating wood by the way of vital inspiration is not without certain objections. In the first place, it can only be performed at those periods of the year when the sap is in motion, and the trees are covered with their leaves. This time, however, is limited to a few months of the year, and the usual practice being to fell timber in the winter, wont and usage are opposed to cutting down trees in the spring and autumn. To meet these objections, M. Boucherie engaged in new experiments, which led him to a means of impregnating timber at all seasons, in winter as well as spring and autumn, and in a very short space of time; this second method is applicable to wood that has already been squared as well as to the round trunk, provided it has been recently felled. To impregnate timber by this process, the logs are placed vertically, and the upper extremities are fitted with an impermeable sack for the reception of the saline solution destined to charge them; the fluid enters from above, and almost at the same moment the sap is seen to begin running out below. There are some woods which include a large quantity of air in their tissues; in this case the flow does not go on until this air has been expelled; once begun, it goes on without interruption. The operation is terminated when the fluid, which drips from the lower part, is of the same nature as that which is entering above. In my opinion this method must be preferable to that by aspiration. In the second mode of proceeding, in fact, we accomplish our object by a true displacement; almost the whole of the sap is expelled, and the saline solution introduced has only to subdue or neutralize the very small quantity of soluble organic matter which may remain adhering to the woody tissue. By accomplishing such a displacement by means of simple water we should undoubtedly obtain results favourable to the preservation of timber, inasmuch as we should have freed it from almost the whole of those matters which are regarded as the most alterable themselves, and the first cause of rotting in timber. The rapidity with which the fluid introduced is substituted for the sap which it displaces, and the quantity of this expelled sap which may be readily collected, exceeds any thing that could have been imagined before making the experiment; thus the trunk of a beech tree about $52\frac{1}{2}$ feet in length by $33\frac{3}{4}$ inches in diameter, and consequently forming a cube of somewhat more than $29\frac{1}{2}$ feet, gave in the course of 25 hours upwards of 330 gallons of sap, which were replaced by about 350 gallons of pyroligneous acid. The liquid which penetrates in this way acts so effectually in displacing the sap, that M. Boucherie says we can readily procure or extract by its means the saccharine, mucilaginous, resinous, and coloured juices contained in trees. It would, perhaps, be possible, and I beg to suggest this idea to colonial planters, to apply the method of displacement to the extraction of the colouring matters of dye-woods. The trade in dye-woods does not extend beyond localities favourably situated for exportation, so that at a certain distance from the shores of the ocean, or the banks of rivers, it is found absolutely impossible to carry on a trade, the material of which is so heavy and bulky as timber. The greater number of the colouring matters found in wood being soluble, it is possible to export them in the state of extract. Various attempts of this kind have already been made; and if they have not been successful, the obvious cause of this lies in the method which has been followed, and which has hitherto consisted in treating the wood reduced to chips by means of boiling water, and then reducing the coloured solution obtained; but it is obvious that in the remote forests of America, or of Africa, where all mechanical means are wanting, nothing but failure could attend upon such a procedure. By the method of M. Boucherie, the main difficulties appear to be got over; there is nothing more to be done, in fact, than to get the trees into the state of logs, and these are generally readily transportable, after which one or more evaporating pans seem all that are further necessary."

The common method of determining the cubic contents of a rough piece of timber, whether stem or branch, is to take the mean of its girth

or circumference beween the butt-end and the top-end, to square the fourth of this mean, to multiply the product by the length, and to deduct an allowance for the bark. But this method does not bring out a result sufficiently near the truth, in cases where the timber is of any considerable value; and a much better one would be to multiply the square of the circumference by the length, and to multiply the product by ·07958. The allowance for bark ought to vary widely in trees of different species, and considerably in different individuals, particularly in the young and the old, of the same species. In England, the customary allowance is one inch for every foot of the quarter of the mean circumference of rough-barked or thick-barked species, such as the oak and elm, and half an inch for every foot of smooth-barked or thin-barked species, such as ash; and in Scotland, it is two inches for every circumference of from 12 to 24 inches, three inches for every circumference of from 24 to 36 inches, four inches for every circumference of from 36 to 48 inches, five inches for every circumference of from 48 to 72 inches, and six inches for every circumference of upwards of 72 inches. The contents of any hewn piece of timber, whose bases are parallel to each other, and whose greatest and least thicknesses are at the ends, may be readily and accurately determined by finding the areas of the two bases and the area of a section parallel to and equidistant from the bases, multiplying this last area by 4, adding to the product the other two areas, and multiplying the same by one-sixth of the length. The measuring of sawn and worked timber in the several departments of carpentry, is noticed in the article Carpenter's Work.

Timber is generally hewn into logs, and sawn into planks and deals, and sold by the load. See the articles Log and Plank. A load of unhewed timber comprises 40 feet, a load of squared timber 50 feet, a load of one-inch plank 600 square feet, a load of 1½-inch plank 400 square feet, a load of 2-inch plank 300 square feet, a load of 2½-inch plank 240 square feet, a load of 3-inch plank 200 square feet, a load of 3½-inch plank 170 square feet, and a load of 4-inch plank 150 square feet.

TIMBER TREE. See Tree, Timber, and Plantation.

TIMOTHY-GRASS. See Phleum.

TIN. One of the metals. It does not occur in many districts of the globe, but is very abundant in a few,—particularly in Cornwall, in part of Bohemia, in Galicia, and in Malacca. The tin mines of Cornwall have been worked from a very remote period, and have sent their produce to very distant parts of the world, and make a conspicuous figure in the constant industry of the south-east of England. The tin of these mines is both extracted from veins in various kinds of matrices, and found in the form of rounded grains among beds of rolled materials which have been deposited by running water; and it occurs both metallically in combination with sulphur and copper under the form of tin pyrites, and oxidizedly in combination with oxide of iron and silex under the forms of tin-stone and wood-tin. The granular ore in the deposits of running water is commonly called stream tin, and contains a very pure oxide, and yields the purest kinds of the tin of commerce; and the veined ore is by far the most abundant, and has a wide diversity of form and character and value, and requires to be subjected to an operose process of metallurgy. The ore, when necessary, is blasted with gunpowder; and, when raised out of the mine, it is divided into as many shares or 'dolls' as there are proprietors and adventurers; and that of each mine is distributed on the adjacent fields. The ore is generally pounded or stamped on the spot, in the pounding-mill; if slimy, it is thrown into a pot, called a buddle, to render the pounding more free, without choking the grates; and if free from slime, it is shovelled into a kind of sloping canal of timber, called 'the pass,' whence it slides by its own weight, and the assistance of a small stream of water, into the box where the 'lifters' work. The lifters are raised by a water-wheel, and are armed at the bottom with large masses of iron of about 1¼ cwt., which pound the ore small enough to allow of its passing through the holes of an iron grate, fixed in one end of the box. It is kept constantly wet by a rill to assist its attrition; and it is carried by a small gutter into the 'fore-pit,' where it makes its first settlement; and the lighter particles run forward with the water into 'the middle-pit,' and thence into the third, where what is called the slime settles. From these pits the ore is carried to 'the keeve,' where it is thoroughly cleansed from its filth, and rendered fit for smelting. It is then carried to works constructed for this operation, and delivered to the smelter, and here it is assayed, to determine its quality, and then fined, and run into moulds of an oblong form; and when cooled, these masses are taken out of the moulds, and under the name of blocks of tin are carried to one of the coinage towns to be coined. A comparatively pure tin—though not so pure as that obtained from the stream ore—is prepared by heating a smelted block from the common ore to very near the point of fusion, and allowing only the most fusible portions of it to melt out,—these being much purer than the less fusible portions. The usual impurities are iron, copper, arsenic, and sulphur; and the worst of these can be dissipated by means of roasting in an intense heat.

Tin has a white colour, and a lustre similar to that of silver; it slowly loses its lustre by exposure to the air, but does not oxidize even under the combined agency of air and moisture; it has a very slight and somewhat disagreeable taste, and emits a peculiar odour when rubbed; it is soft and inelastic, can be easily cut with a

knife, and, when bent backward and forward, produces a peculiar crackling noise; it is inferior to several metals in ductility and tenacity, but possesses a very high degree of malleability; it has a specific gravity of 7·299 after being hammered, and of 7·291 after being melted; and it fuses at 442° Fahrenheit, is not volatilized from a state of fusion, crystallizes in rhombs when allowed to cool, and takes fire and burns with a white flame when heated to a full degree of redness. It forms a protoxide, while in a state of fusion, or under the action of any one of many acids; it passes into peroxide by combustion at a full red heat; and it readily combines in two proportions with both chlorine and sulphur, so as to form chlorides and sulphurets.

Pure or nearly pure melted tin, when briskly agitated in a heated mortar or wooden box till it cools, settles into a powdery form of very little lustre, commonly called tin powder or tin filings; and this substance has a place in the pharmacopœias as a powerful anthelmintic, and as an old and indirect remedy for hysteria and hypochondriasis. Thin plates of iron, coated with tin by means of immersion in it while in a state of fusion, constitute the well-known white-iron or sheet-tin of the arts, so extensively used for making canisters, saucepans, and hundreds of other utensils. Alloys of tin and other metals constitute pewter, solder, bronze, and bell-metal. The peroxide of tin, when melted with glass, forms a white enamel.

TINCAL. See Borates.

TINCTURES. Alcoholic solutions of such proximate principles of organic bodies as are soluble in proof or extra-proof spirit. Those used in medicine are very numerous; and differ from aqueous infusions and decoctions chiefly in the stimulating nature of their menstruum, in the greater number or superior strength of their contained principles, in their freedom from tendency to spontaneous decomposition, and in their comparatively high gratefulness to feeble or squeamish stomachs. A large proportion comprise, in a more or less compound state, such proximate principles as the saccharine, the gummy, the extractive, the resinous, the astringent, the acidulous, and the alkaloidal; and most never require more alcohol than is contained in proof spirit, and will even admit subsequent additions of water without suffering any decomposition or precipitation; while a few either contain such skittish or refractory principles as the essential oils, or require the constant presence of very strong extra-proof spirit in order to the maintenance of their proper character. Tinctures are made by macerating dried and bruised ingredients, chiefly of a vegetable kind, during from six to fourteen days, in a temperature not exceeding 80° Fahrenheit; and are then filtered through bibulous paper, and afterwards kept in well stopped bottles. Few tinctures are suitable remedies in any cases of acute disease; and most, when long or often used in chronic cases, are liable to create an appetite for dram-drinking; and only such as those of digitalis, myrrh, opium, and aloes are serviceable in veterinary medicine, —and then, not for internal administration, but as applications to wounds or inflamed surfaces. See the article Alcohol.

TINE. A large tooth or spike of a harrow, a grubber, or any similar implement.

TINEA. A genus of moths, constituting the type of the family Teneidæ. The moths of this family are great in number, small in size, and very mischievous in habits; and they comprise some species which abound in dwelling-houses, and work some serious and well-known devastations. Their palpi amount to four, and are commonly distinct, and not concealed by hairs or scales; their upper wings are long and narrow, and, when closed, assume the form of a rounded ridge, as if they had been moulded on the body, —and sometimes incline on the sides almost perpendicularly,—and often stand up at the hinder extremity like a cock's tail; and their under wings are proportionally large, and generally plaited. The caterpillars are quite or nearly smooth, and have each sixteen feet, and live in habitations which are generally made of the same substances as their food, and have a curious fabrication, and are in some instances fixed, and in others carried about in the same sort of way as snails carry their shells. Two species are very destructive to bee-hives; and three to respectively corn, clothes, and fur. See the articles Wax-Moth, Corn-Moth, Clothes-Moth, and Fur-Moth.

The genus tinea, as distinguished from the other genera of the Teneidæ, may be known by the inferior palpi scarcely projecting beyond the forehead, by the proboscis being very short, and formed of two small membranous and disjointed threads, and by the head being furnished with a crest. It comprises the corn-moth, the clothes-moth, the fur-moth, the destroying-moth, and about twelve or thirteen other British species, all of which are greater or less pests in granaries and dwelling-houses. Each, in general, lives and feeds on some particular substance in preference to all other substances; yet most can accommodate themselves to a wide variety of circumstances, and may, in a limited sense, be pronounced miscellaneous feeders or general devourers. "They sometimes,"[25] says Mr. Duncan, "appear under circumstances where it is extremely difficult to account for their having obtained access, so as not to render it surprising that the belief should be so general, that they are bred or generated (that is to say, spontaneously) in the substances where they are found. This notion, however, cannot for a moment be entertained; and any object liable to their attacks, such as a piece of fur, if so firmly closed up that the parent moths cannot find entrance, will remain in perfect security, unless

it so happen that the germ of the mischief has been closed up along with it. Exposure to a considerable degree of dry heat, wherever that is practicable, is the easiest and most effectual mode of destroying the eggs and larvæ. Immersion in boiling water is, of course, equally effectual. The objects preserved in museums are protected from moths, as well as other destructive insects, in various ways. Corrosive sublimate, dissolved in spirits of wine, has been a good deal used of late, and is said to be very efficacious. Spirits of turpentine, oil of petroleum and camphor, although, perhaps, they do not actually kill the noxious insects, are yet very useful in driving them away. A preparation which speedily kills them, and which is said to be the best possible preservative, is that called Becœur's soap, which consists of the following ingredients in the proportions indicated:—2 lbs. of arsenic in powder, 2 lbs. of white soap, 12 oz. of salt of tartar, and 4 oz. of lime in powder. Sulphurous fumigations have long been used with advantage, but must be employed with caution, as they are apt to injure the colour of certain objects."

TIPULA. A genus of dipterous insects, belonging to the nemocera family, and constituting the type of a group called Tipulariæ. The species of this group are very numerous, and have singularly long legs and narrow elongated bodies, and are popularly known by many quaint names such as crane-flies, long-legs, tailors, and Jenny-the-spinners. Their antennæ have thirteen joints,—the radical one of which is cylindrical, the second cup-shaped, and the rest cylindrical and bearing each at the base a few verticillate hairs; the palpi are projecting, incurved, cylindrical, and four-jointed, and have the terminal joint elongated; the ocelli are a-wanting; and the wings are lanceolate and spreading. The larvæ and pupæ of some inhabit the water and form vegetable galls; and the larvæ of others live within the soil of meadows and arable land, and frequently make great devastation by loosening and destroying the roots of herbage plants and gramineous crops. Not fewer than at least forty species occur in Britain; and several of them are very common, and often work great havoc. Two of the worst—the one a true tipula, and the other a species of the genus cecidomyia—are noticed in the articles Grub and Wheat-Fly; and these serve as a sufficiently ample specimen of the whole group.

TISSUE, in Botany. All the organs and parts of plants are composed of little cells or vesicles, tubes, and fibres; or, in other words, of cellular, vascular, and woody tissue. The first is of universal occurrence; but the latter are partially or entirely wanting in many plants.

Cellular tissue consists of membranous vesicles, or little bladders, which cohere with each other, more or less perfectly, by their contiguous sides. These are not perforated with holes or visible pores, at least originally: they are at first of extreme tenuity; but are often thickened by the deposition of more solid matter upon their inner surface, either in regular layers, in bands, dots, or otherwise, and which sometimes accumulates so as completely to fill the cell. Their form depends entirely upon the circumstances in which they are placed. When separate they are round or oblong: when equally pressed together, they become twelve-sided, the cross-section being six-sided: when stretched lengthwise, they are rendered prismatical, cylindrical, &c. They contain fluid, and often solid matter, such as starch, the green colouring substance of plants, and sometimes minute crystals, which, when slender, are termed *raphides.* Common cellular tissue, or *parenchyma,* constitutes all the pulpy and succulent parts of plants, the pith, the whole of leaves, excepting the veins, and a portion of the bark, &c. But it is capable of acquiring excessive hardness; as it does in the stone of a peach, and in the bony skin of some seeds. One or more fine spiral lines are sometimes observed on the walls of a cell; forming what is called *fibro-cellular tissue.* See the article Cellular Tissue.

Woody tissue consists of vesicles of cellular tissue drawn out into tubes of extreme tenuity and toughness, their sides being very thick in proportion, each end tapering into a sharp point. These fibres are closely applied to each other by their sides, and form bundles or coarser fibres stretching through the plant lengthwise, affording the necessary degree of strength, and also serving, it is supposed, for the upward conveyance of the sap. This tissue is not confined to the wood, but is also found in the bark; and the veins of leaves, of petals, &c., are chiefly composed of it. In all coniferous trees (pines, firs, &c.), and in a few others with aromatic secretions, the tubes of woody tissue (which are larger than ordinary woody fibre) are marked along their sides with circular gland-like disks, appearing like a row of small holes.

Pitted, or vasiform tissue, consists of large tubes, either composed of ordinary cylindrical cells placed end to end and opening into each other, or often without the appearance of such composition: the walls are marked with pits or dots, produced by the unequal deposition of more solid matter on the inside. They were long considered as true vessels, and have been called *dotted ducts.* The pores conspicuous on the cross section of most kinds of wood, are the large open orifices of these tubes.

Vascular tissue consists of uninterrupted membranous tubes, marked with transverse bars or rings, or with a spiral fibre adherent to their inside. The type of vascular tissue is the *spiral vessel;* in which the closely coiled spiral fibre is capable of unrolling with elasticity. The thin and delicate membrane which confines the fibre being transparent, the latter only is visible, and resembles a slender coil of fine wire. In their

unrolled state, they are readily examined by breaking almost any young shoot or leaf-stalk, and pulling the extremities gently asunder, when the uncoiled fibres appear to the naked eye like a fine cobweb. In stems furnished with pith, the spiral vessels usually occupy a circle immediately around it: thence they proceed to the veins of the leaves, and of all parts which are modifications of leaves. *Ducts* are vessels in which the spiral fibre is incapable of unrolling. The turns of the coil sometimes touch each other, forming what are called *closed ducts*, which are only to be distinguished from spiral vessels by this character: often the turns are distant, or broken into separate rings placed at considerable intervals (*annular ducts*); sometimes they cross each other (*reticulated ducts*), or are broken up into short irregular bands. Occasionally nearly all these varieties may be observed in different portions of a continuous vessel. Ducts occur abundantly among the woody tissue of almost all plants. See the article Vascular Tissue.

Laticiferous tissue consists of a peculiar system of vessels, which have only recently been made known. The vessels of the latex are those in which peculiar products of plants (such as milky juice, &c.) are elaborated and contained. They are distinguished from all other vessels by their numerous anastomosing branches, and also by their irregular contractions and expansions. Their average diameter is said to be one-fourteen hundredth of an inch. Their old trunks are often very much larger; but their ramifications, which proceed to the surface of the organs, and form a most delicate net-work upon the hairs, are so minute that they are only to be discovered with the aid of the most powerful microscopes.—*Gray.*

TIT, or Titmouse,—scientifically *Parus*. A genus of passerinous birds, of the conirostrous family. They have slender, short, conical bills, with little hairs at the base, and with the nostrils concealed among feathers; and they possess exceedingly active powers, and display remarkable agility, and flit constantly from branch to branch, and pass rapidly through a great variety of positions; and they are, in a considerable degree, omnivorous, and tear asunder the seeds on which they feed, and devour all insects whom they can find. and even kill and eat whatever small birds they happen to find sick or are otherwise able to master. Five or six species occur in Britain; and though differing in size, colour, and some other particulars, have a great similarity in habits, feeding, and general character.

The tom-tit, or blue-headed tit, or blue whaup, *Parus cæruleus*, is, in many districts, the most common species, and in almost all a peculiarly interesting one, at once for its pretty appearance, for the erroneous notions which are generally entertained respecting its habits, and for the war of extermination which is often carried on against it. See the article Hedge-Birds. The upper surface of its body has an olive-coloured plumage; the lower surface is yellowish; the top of the head is a fine blue; the forehead is white; and the cheek is white, surrounded with black. He is so knowing a little fellow respecting the nicest morsels of his vegetable diet, and at the same time so prying and impudent and fearless, that one can easily understand how he has acquired a very bad name among the great majority of farmers and gardeners. "He prefers what is delicate as well as nutritive, and is particularly fond of every sort of nuts and the larger seeds, which most resemble nuts in quality, such as the seeds of sunflower, hemp, pease, and the like. It may well be supposed that his small beak, hard though it be, is inadequate to manage such large seeds in the way they are shelled by the linnet or the bullfinch; but the tom-tit is a most ingenious seed-breaker. In the case of a pod of Prussian-blue pease, for example, he will first peck a hole through the shuch or shaup to get at a pea; and this, when he has procured it, he fixes between his claws, while he hammers away at it with his little bill till he gets at the mealy kernel, which he hollows out and devours, leaving the empty shell. He does the same with a hemp seed, and it is surprising to observe how small a hole in the shell will sometimes suffice to enable him to get at the whole contents. Yet he certainly commits very few or trifling depredations on any sort of garden fruit; and, upon the whole, may be considered as producing more benefit than injury to cultivators."

The long-tailed tit, *Parus caudatus*, is a common and well-known species; and remains in Britain throughout the year; and frequents woods, shrubberies, and other places of retreat and shade. His total length is about $5\frac{1}{2}$ inches; the upper surface of his body has black plumage; his wing-coverts are brown; the upper part of his head and all the parts beneath are white; and his tail is longer than his body. The female builds her nest on the branches of small trees, and roofs it over, and lays from 10 to 12 eggs.

The cole-tit, *Parus ater*, and the marsh-tit, *Parus palustris*, have a considerable resemblance to each other, and are distinguished from the tom-tit by the black colour of their head, by the ash colour of the upper part of their body, and by whitishness instead of yellow in the lower part of the body. The cole-tit has a shining glossy black head and throat; and the marsh-tit has a dull non-shining black head and chin. The cole-tit, besides feeding on the same sorts of food as the tom-tit, though not so omnivorously, is very fond of pine seeds, and on this account abounds most in pine and fir forests and plantations; and it is the only species of tit which builds in holes on the ground, in preference to holes in trees and walls. The marsh-tit is perhaps more common in this country than the cole-tit; and a family of them may often be seen in the autumn attacking the ripe seeds of a sun-

flower, which, when they have discovered, they daily visit so long as a single seed remains, holding each seed firmly between their claws till it is neatly unkernelled. During autumn and winter both species come into gardens and orchards, like the tom-tit, in families or small flocks, but do little or no injury.

The greater tit, oxeye, joe-bent, or willow-biter, *Parus major*, has a shining black head and breast like the cole-tit, but is readily distinguished from all the other species by being nearly a third longer, while it is more gaily coloured with yellow, olive, and blue. The greater size and strength of its bill renders it more capable of digging into the crevices of the bark of trees than any of the preceding; and it is also fonder of climbing up the trunks of trees than the tom-tit, in pursuit of lurking grubs and beetles. In this way, it is of essential benefit in orchards and gardens, and ought not to be grudged a walnut or a filbert in reward for its services; and even were all the roots and seeds reckoned up which it may occasionally eat, they would be of such small amount as to be unworthy of consideration.

TITANIUM. One of the rare and recently discovered metals. It was not satisfactorily proved to be a distinct elementary substance till the year 1822. Minute crystals of it are found in the slug of iron works; and have a cubic form, a coppery colour and lustre, a specific gravity of 5·3, and a hardness so great as to scratch a polished surface of rock crystal. Titanium combines with oxygen, chlorine, and sulphur, so as to form oxides, chlorides, and sulphurets.

TITHES. The tenth part of the increase yearly arising from the profits of lands, the stock upon lands, and the industry of the occupants, allotted to the clergy for their maintenance.

The custom of giving and paying tithes is very ancient. In Gen. xiv. 20, Abraham gives Melchizedek the tenth of all the spoils taken from the four kings defeated by him. Tithes were first legally enjoined by Moses. They were not established by Christ. The early Christian ministers lived upon the oblations of the devout. For the first three hundred years after Christ, no mention is made in ecclesiastical history of any such thing as tithes. The first authority produced (setting aside the apostolical constitutions, which few of the advocates of tithes will insist on) is a provincial synod at Cullen, in 356, in which tithes are voted to be God's rent. After the church had enjoyed tithes without disturbance for two or three centuries, the laity in the eighth century obtained possession of part of the tithes, and appropriated them to their own uses. Some time afterwards they restored them, or applied them to the founding of monasteries or chapters. In 1179, the third council of Lateran commanded the laymen to restore to the church all the tithes which they yet held. Upon the first introduction of tithes, though every man was obliged to pay tithes in general, yet he might give them to what ministers he pleased, which were called *arbitrary consecrations of tithes;* or he might pay them into the hands of the bishop, who distributed among his diocesan clergy the revenues of the church, which were then in common. But when dioceses were divided into parishes, the tithes of each parish were allotted to its own particular minister; first by common consent, or the appointments of lords of the manors, and afterwards by the written law of the land. However, arbitrary consecrations of tithes took place again afterwards, and became common in England till the time of King John. This was probably owing to the intrigues of the regular clergy, or monks of the Benedictine and other rules, and will account for the number and riches of the monasteries and religious houses which were founded in those days, and which were frequently endowed with tithes. But, in process of years, the income of the laborious parish-priests being scandalously reduced by these arbitrary consecrations of tithes, it was remedied in England by Pope Innocent III., about the year 1200, in a decretal epistle, sent to the Archbishop of Canterbury, which enjoined the payment of tithes to the parsons of the respective parishes, where every man dwelt, agreeably to what was afterwards directed by the same pope in other countries. This put an effectual stop to all the arbitrary consecrations of tithes, except some traces which still continue in those *portions of tithes*, which the parson of one parish has, though rarely, a right to claim in another; for it is now universally held that tithes are due, of common right, to the parson of the parish, unless there be a special exemption. This parson of the parish may be either the actual incumbent, or else the appropriator of the benefice; appropriations being a method of endowing monasteries, which seems to have been devised by the regular clergy, by way of substitution to arbitrary consecrations of tithes.

Mr. Smith observes that tithes, as well as other similar taxes on the produce of the land, are, in reality, taxes upon the rent, and, under the appearance of equality, are very unequal taxes; a certain portion of the produce being, in different situations, equivalent to a very different portion of the rent. In some very rich lands, the produce is so great, that the one-half of it is fully sufficient to replace to the farmer his capital employed in cultivation, together with the ordinary profits of farming-stock in the neighbourhood. The other half, or, what comes to the same thing, the value of the other half, he could afford to pay as rent to the landlord, if there was no tithe. But, if a tenth of the produce is taken from him in the way of tithe, he must require an abatement of the fifth part of his rent, otherwise he cannot get back his capital with the ordinary profit. In this case, the rent of the landlord, instead of amounting to a half, or five tenths, of the whole produce, will amount only

to four tenths of it. In poorer lands, on the contrary, the produce is sometimes so small, and the expense of cultivation so great, that it requires four fifths of the whole produce to replace to the farmer his capital, with the ordinary profit. In this case, though there were no tithe, the rent of the landlord could amount to no more than one fifth, or two tenths, of the whole produce. But if the farmer pays one tenth of the produce in the way of tithe, he must require an equal abatement of the rent of the landlord, which will thus be reduced to one tenth only of the whole produce. Upon the rent of rich lands, the tithe may sometimes be a tax of no more than one fifth part, or four shillings in the pound; whereas, upon that of poorer lands, it may sometimes be a tax of one half, or of ten shillings in the pound. It is a great discouragement to the improvement of land, that a tenth part of the clear produce, without any deduction for the advanced expense of raising that produce, should be alienated from the cultivator of the land to any other person whatever. The improvements of the landlord and the cultivation of the farmer are both checked by this unequal tax upon the rent. The one cannot venture to make the most important, which are generally the most expensive improvements, nor the other to raise the most valuable, which are generally the most expensive crops, when the church, which contributes no part of the expense, is to share so very largely in the profit. When, instead either of a certain portion of the produce of land, or of the price of a certain portion, a certain sum of money is to be paid in full compensation for all tax or tithe, the tax becomes, in this case, exactly of the same nature with the land tax of England. It neither rises nor falls with the rent of the land. It neither encourages nor discourages improvement. The tithe, in the greater part of those parishes which pay what is called a *modus*, in lieu of all other tithes, is a tax of this kind.

It is well known, and has often been lamented, even by the clergy themselves, that this method of raising a revenue for their subsistence, is a continual source of dispute between the clergy and their parishioners, and contributes to obstruct the usefulness of their ministry.

TITHONIA. An ornamental, tropical, evergreen shrub, of the sunflower division of the composite order. It constitutes a genus of itself, and bears specifically the descriptive name of *tagetiflora* or marigold-flowered. It was introduced to the hothouses of Britain about 30 years ago from Vera Cruz; and it attains a height of about 10 feet, and carries orange-coloured flowers from July till October.

TITMOUSE. See Tit.

TITTMANNIA. A genus of ornamental exotic plants, of the figwort family. Two annual species, the ovate-leaved and the clammy, both small, early-blooming trailers of 2 or 3 inches in height, have been introduced to British collections from Polynesia and India; and 6 or 7 other species are known.

TOAD,—scientifically *Bufo*. A genus of batrachian reptiles, of the frog family. They have a comparatively bulky body, covered with warts or papillæ,—a thick lump situated behind the ear, pierced with pores, and emitting a milky and fœtid humour,—no teeth,—and slightly elongated hind feet; they are bad leapers, and generally avoid the water; they have a hideous and disgusting appearance; and their bite, their saliva, their urine, and even their perspiration are commonly, but erroneously, regarded as poisonous. See the article Frog.

The common toad, called by the old zoologists *Rana bufo*, is a well known frequenter of the moist and shady quarters of kitchen gardens, and of other similar situations, where its presence is most repugnant to the ignorant and the fastidious. Its predominant colour is grey brown or reddish grey, sometimes olive or blackish; its back or upper surface is studded with rounded tubercular warts as large as lentils; its belly or under surface is still more closely set with smaller tubercles; and its hind feet are semi-palmate. It inhabits dark or deeply shaded places in summer, and lies dormant in an excavated hole during winter. It couples in the water in March and April. The female produces innumerable small ova, united by a transparent gelatinous substance in two strings, which are often 20 or 30 feet long; and the male assists with his hind feet in extracting the ova. The tadpole is blackish; and at the time of losing its tail and acquiring legs, is the smallest of the European species. The common toad feeds on flies, ants, and other insects, and therefore does good and no harm in gardens; it has a cry of somewhat similar sound to the barking of a dog; it is preyed upon by buzzards, owls, snakes, and some other animals; and it begins to breed at four years of age, and commonly lives upwards of 15 years, but has been known, in some curious instances, to attain a remarkable longevity.

Most of the other European species of toads are popularly called frogs,—such as the bush frog, the variable frog, and the midwife frog; and one, which has a light brown colour, and is eaten in some places as if it were a fish, *Bufo fuscus*, is popularly called the natter-jack. Some of the species foreign to Europe are remarkably large.

TOADFLAX,—botanically *Linaria*. A diversified genus of plants, of the figwort family. It was included by the old botanists in the genus antirrhinum; and it takes both its botanical and its popular names from the similarity of its leaves —particularly those of the common species—to those of cultivated flax. Six species grow wild in Britain; about 70 have been introduced from other countries; and between 20 and 30 more are known. A few of those in Britain are evergreen undershrubs, a greater number are perennial-rooted herbs, and more than the half are

annuals; a few are more or less tender, and all the rest are quite hardy; a few have a height of from 2 to 5 feet, and most of the others have a height of from 3 to 15 inches; a large number have either white, brown, greenish, blue, or violet flowers, and the rest have either yellow or purple flowers; about a dozen of the herbaceous species have prostrate stems, and either lobed or subentire, angular or toothed leaves, and the rest are erect, and have their lower leaves either opposite, whorled, or scattered.

The common toadflax, *Linaria vulgaris*, called by the old botanists *Antirrhinum linaria*, is a perennial-rooted, annual-stemmed weed of the hedges and field-borders of Britain. Its stem is about a foot high; its leaves are linear-lanceolate, crowded, and irregular; and its flowers grow in terminal spikes, and are scentless, and have a yellow colour, and bloom from June till September.—The creeping-rooted toadflax, *Linaria repens*, is a perennial-rooted but comparatively rare weed of the banks and hills of the calcareous districts of England. Its stem is panicled and about a foot high; its leaves are linear, smooth, glaucous, partly whorled, and partly scattered; and its flowers are sweet-scented, and have a greenish colour, and bloom from July till October. —The ivy-leaved toadflax, *Linaria cymbalaria*, is a perennial-rooted indigen of old walls and similar situations in some parts of England, and possesses sufficient ornamental attractions to hold a place in flower-gardens, and especially on conspicuous walls. Its root is fibrous; its stems are procumbent or trailing, cylindrical, much branched, smooth, and leafy; its foliage is evergreen, and of a deep shining verdure, often tinged with violet, and quite smooth; its leaves are alternate, stalked, and similar in shape and appearance to those of ivy; and its flowers are solitary, and grow on long axillary footstalks, and have a small size, a very elegant form, and a variegatedly blue and violet corolla, and bloom from May till November. The whole plant hangs most beauteously from old walls, and exhibits there the appearance of rich, dense, flowing festoons. One variety of it, *L. c. variegata*, has variegated leaves; and another variety, *L. c. alba*, has white flowers. —The fluellin toadflax, or sharp-pointed fluellin, *Linaria elatine*, is an annual indigen of the corn-fields of some parts of England; and is sometimes very abundant on gravelly and chalky soils. Its stems are procumbent, spreading, and about 6 inches long; its leaves are lobed, halbert-shaped, and comparatively slender; and its flowers have yellow and purple colours, and make a pretty appearance, and bloom from July till November.— The spurious toadflax, or round-leaved fluellin, *Linaria spuria*, is also an annual indigen of the corn-fields of England. Its stems are procumbent; its leaves are subentire and rather larger and less slender than those of the preceding; and its flowers are larger, deeper-coloured, and more conspicuous than those of the preceding, and bloom from July till September. — The small toadflax, *Linaria minor*, is an annual weed of the sandy fields of some parts of England. Its stem is erect and about 6 inches high; its lower leaves are regularly arranged; and its flowers have a violet colour, and bloom from June till November.

TOBACCO,—botanically *Nicotiana*. A genus of cultivated and ornamental plants, of the nightshade family. The corolla is monopetalous and funnel-shaped or bell-shaped; the stigma is emarginate; and the seeds are numerous, and enclosed in a two-celled capsule. Upwards of 30 species, besides a number of varieties, have been introduced to the gardens and the botanical collections of Britain. Two of the species are evergreen shrubs, two are evergreen herbs, one is a biennial, and all the rest are annuals; several have a height of only a few inches, but most have a height of from 3 to 8 feet; nearly all have either pink, white, or herbaceous-coloured flowers, and bloom in the latter part of summer or early part of autumn; a few are so tender as to be cultivable only in the greenhouse or the stove, and the rest are more or less hardy, and may, with proper precautions, be raised from seed in the open ground; a large number, irrespective of varieties, are cultivated for purposes of luxury or economy or medicine, and both these and all the others make either a curious or a very ornate appearance in the flower-garden.

The History of Tobacco.—Six of the species of tobacco now in British collections have been introduced at various periods since about the close of the 17th century from China, Egypt, Persia, Nepaul, and Australia; and all the others have been introduced at various periods, since the latter part of the 16th century, from Yucatan, Vera Cruz, Chili, Peru, Brazil, Columbia, Buenos Ayres, Havannah, and several other parts of America. But the species first known in Europe, and often called par excellence the tobacco plant, and now bearing the botanical name of *Nicotiana tabacum*, was discovered by the Spanish invaders of America under Cortes, in the year 1519, in the province of Tabaco in Yucatan, and is thought by some botanists to have been not very extensively diffused beyond that province at the time of its discovery. The natives made universal use of the plant, and held it in high esteem, and even treated it with veneration. They smoked it as an article of luxury; and employed it as a medicine for all kinds of diseases; and used it to allay the pains of hunger and thirst, in their distant hunting expeditions; and even laid it on the altar as the most acceptable offering which they could make to their gods.

Cortes carefully enquired into all the uses of tobacco, and made himself acquainted with the mode of cultivating and preparing it; and he speedily procured several plants of it, and transmitted them to Spain, accompanied by an accurate account of the virtues, real and imaginary, which it was said to possess. An unhappy disease, which had been imported from America at the first return of Columbus's fleet, raged about this time with fearful virulence in Spain; and the tobacco plant was represented to be an infallible remedy for it, and in consequence received a ready and zealous welcome. But when, after a time, it was found to be no more effectual than the usual remedies, it naturally sank into

a depth of disrepute proportioned to the greatness of the hopes it had excited. It therefore did not at this time come into extensive use in Spain for any medical purpose; it was even slowly, and very sparingly, diffused as an article of luxury; it never became an object of commerce, and, for more than forty years after its first introduction, seems never to have been communicated from Spain to any other nation. Near as it was, we do not learn that even Portugal received the plant from the sister kingdom, but seems to have imported it from one of its own colonies in America; and it was certainly from Portugal, and not from Spain, that its general diffusion over Europe and the East commenced.

About the year 1560, Jean Nicot of Nismes, when acting as French ambassador at the Portuguese court, was presented with a plant of tobacco, as an exotic of great curiosity and rarity, newly imported from the American settlements; and like every one else at that period, he was inquisitive about all the strange productions of the new world, and received it, as Neander says, *lubenti animo*. Accordingly, at his return to France, about the year 1561 or 1562, he took with him a considerable number of tobacco plants, and made his countrymen acquainted with their history and uses. The new exotic was named Nicotiana in honour of its introducer; it was eagerly welcomed by the spirit of inquiry which prevailed even at that time in France; it was carefully and scientifically examined by both naturalists and physicians; its properties and qualities were investigated; such virtues as it possessed were discovered, and many which it did not possess were supposed to be discovered. It was soon received as a valuable and useful addition to the Materia Medica Its introduction seemed to form a new era in the history of physic. Diseases and complaints, which were hitherto thought incurable, were now supposed to have found a remedy. It entered, in the shape of solutions, decoctions, powders and essences, into the composition of almost every drug; and it was applied as a general panacea to almost every human disease. Such an exaggerated idea of it prevailed that Catherine de Medicis thought that her own name would derive additional glory from being connected with it; and she ordered it to be called, no longer Nicotiana, from the name of its introducer, but Herba Reginæ, in honour of herself. But, whether owing to the mode of cultivating it being imperfectly understood, or to some laws of Catherine regarding it, its diffusion for a long time bore no proportion to its fame. So late as the reign of Henry IV., it was raised only in small quantities in gardens, and used only for medical purposes; and not till the reign of Louis XIII. did it begin to come gradually into request as a luxury, and to be taken in the shape of snuff. The laws passed regarding it by Catherine, limited the cultivation of it in several provinces, and altogether prohibited it in others; and these continued in force, more or less modified, for a long series of years.

About the same time that Nicot introduced the tobacco plant into France, St. Croix, then acting as papal legate in Portugal, introduced it into Italy; and here, also, it attained great repute as a medicinal herb,—though, as the temperature of the Italians is too lively, and their climate too genial, to require such adventitious excitement, it was not adopted by them for the purpose of smoking. About this time, too, it was introduced into Russia, by way of Astrachan, from either Portugal or Italy,—into Holland and most parts of Germany, through means of the extensive intercourse between the Hanse towns and the Italians states,—into the countries of the Levant, through the eastward commerce of Venice and Genoa,—and into the vast regions around the Persian gulf and beyond the Indian ocean, in connexion with the vast oriental commerce of Portugal which followed the discovery of the passage round the Cape of Good Hope.

Tobacco was first introduced to England, on a small scale, from France about the year 1570; and was afterwards introduced, on a large scale, from Virginia in 1586. It excited little notice between these two periods, and probably was raised only in small quantities, in physical gardens, for experimental or medicinal purposes; but immediately after its second introduction, it drew the attention of some of the greatest personages in the country, and began to come into extensive use as a luxury. Sir Walter Raleigh saw it smoked by the gentleman who introduced it; and soon acquired a taste for it, and became an easy prey and a willing slave to the pipe. He next commenced to teach the art of smoking to his friends, and was in the habit of giving 'smoking parties' at his house, when the guests were treated with nothing but a pipe, and a mug of ale and nutmeg. The example of so gay and fashionable a man, who might be said to lead the taste of the age, speedily spread its influence at court; the example of the court was soon communicated to the country; and in a few years smoking became pretty general in England. During the reign of Elizabeth, this fashion got into great repute; and some writers hint that she countenanced it by her own example. "It soon became of such vogue at her courte," at all events, "that some of the great ladies, as well as noblemen therein, would not scruple to blow a pipe sociably;" and if it were usual for the ladies to smoke, we may readily imagine how much more it must have been so for the men. In one of Lord Somer's Tracts, entitled "A pleasante invective against Poets, Pipers, Players, Jesuits, and such like catterpillars of the Commonwealth," the practice of ladies smoking is also hinted at; and Mr. William Prynne, in his famous Histriomastrix, mentions, that among the refreshments offered to ladies in his own time, "it was not uncommon to offer them the tobacco-pipe." But the successor of Elizabeth found cause to be fully more zealous in denouncing tobacco than she had been in praising it; and the increase of the consumption of this article during her reign, was only equalled by its decrease during his. His famous "Counterblast to Tobacco" is not more a literary curiosity than a monument of his indignant abhorrence of the odious weed; and a preamble to an act of parliament, passed in 1604, for raising the importation duty upon it from 2d. to 6s. 8d. per pound reveals some mighty public reasons for his opposition to it, and shows how soon and dreadfully it began to desolate its victims. "Whereas tobacco," says that document, "being excessively taken by a number of ryotous and disorderly persons of meane condition, whoe, contrarie to the use which persones of good qualitie do make thereof, do spend most of their time in that evile vanitie, to the evile example and corrupting of others, and also consume that wages which many of them get by their labour, and wherewith their families should be relieved, not caring at what pryce they buy that drugge, but rather divising how to add to it other mixtures, thereby to make it the more delightful to the taste, though so much the more costlie to their purses; by which great and immoderate taking of tobacco, the health of a great number of the people is impayred, and their bodies weakened and made unfit for labour, and the estates of many mean persons so decayed and consumed, as they are thereby driven to unthriftie shifts onlie to meynteyn their gluttonous exercise thereof; besides, that also a great part of the treasure of the lande is consumed by this only drugge so licentiously abused by the meaner sorte; all which enormous inconveniences ensuing therefrom, we do well perceive to proceed principally from the great quantity of to-

bacco daily brought into this Our realme of England and dominions of Wales, from the parts beyond the seas." From that period down to the present day, the history of tobacco in Britain exhibits principally a tissue of mere fiscal regulations respecting the public revenue from it, and an outspread and increasing waste of property and life and morals from the operation of its narcotism.

The Cultivated Species of Tobacco.—The common or Virginia tobacco, *Nicotiana tabacum*, is an annual. Its root is fibrous and large; its stem is erect, cylindrical, villous, slightly viscid, branched, and commonly from 4 to 6 feet high; its leaves are sessile, slightly decurrent, alternate, large, entire, oblong, pointed, strongly midribbed, pale green on the upper surface, and still paler on the under one,—the lowermost about two feet long and four inches broad; its flowers grow in large terminal panicles, and have a bell-shaped calyx and a tubular, cup-mouthed, very viscid corolla, and bloom in July and August; its corolla is twice as long as its calyx, and has a pale greenish colour in the tube and a pale red or pink or rose colour in the mouth; and its fruit is an ovate capsule, containing many small kidney-shaped seeds, and opening at the apex. Nine very distinct varieties are in cultivation,—the Verdan, the lute, the pallescent, the attenuated, the slender-stalked, the wing-stalked, the tongue-leaved, the long-leaved, and the great broad-leaved; and the two last of these commonly attain nearly double the height of any of the others, and even rise on rich moist soils to the height of 10 feet,—and the broad-leaved has large, oval-shaped, roughly glutinous leaves, generally about 18 inches in length and 14 in breadth, and has upright and purplish-coloured flowers. The Virginian tobacco is the species most extensively, or even generally, cultivated in America.

The rustic or green tobacco, *Nicotiana rustica*, is also an annual and a native of America, and is supposed to have been introduced to Britain about the same time as the preceding species. Its stem is upright, and commonly from 3 to 5 feet high; its leaves are stalked, ovate or somewhat heart-shaped, deeply furrowed, of a comparatively dark green colour, from 9 to 12 inches long, and from 5 to 8 inches broad; and its flowers are of a dull yellowish green colour, and have a cylindrically tubular corolla, scarcely longer than the calyx, with short, blunt, recurved segments, and bloom from July till September. This species is the one principally cultivated in the north and centre of Europe, and is hardier and more suited to the climate of Britain than the Virginian species, and, when grown with us in the open ground, is generally ripening to seeds at the time when the Virginian is but beginning to bloom. Its seeds also retain their vitality in the ground during a number of years; so that wherever a crop of it has been grown, seedling plants will spontaneously arise through a series of seasons.

Among the other cultivated tobaccos are the repand, *N. repanda*, a hardy annual of commonly about 2 or 3 feet in height, carrying white flowers in June and July, and introduced from Havannah in 1820; the wave-leaved or sweet-smelling, *N. undulata* or *N. suaveolens*, a greenhouse, evergreen, herbaceous perennial, of commonly about 2 or 3 feet in height, carrying white flowers from May till September, and introduced from Australia in 1800; the shrubby, *N. fruticosa*, an evergreen shrub, of commonly from 4 to 6 feet in height, carrying pink-coloured flowers in July and August, and introduced from China in 1699; and two or three or more hardy annuals, of very similar appearance to the Virginian and the rustic, principally from 3 to 5 feet high, carrying either pink, red, white, or greenish flowers for some time between June and September, and introduced at various periods from America. The kinds most suited to Britain, however, are the Virginian for the garden and the rustic for the field.

The Cultivation of Tobacco.—Tobacco, in some one or other of its hardy varieties, can grow and prosper in all the temperate regions of the world up to a high latitude; and is extensively cultivated in the Low Countries, in Germany, and even in Sweden; and might, beyond all question, be produced to any desirable amount in the British Islands. It was raised in the open ground in England, immediately after being introduced; and was with difficulty driven out of experimental British cultivation by the opposition of King James; and was grown, with the most promising results, on the banks of the Teviot and the Tweed up till the application of the prohibitory laws to Scotland in 1782; and has been successfully raised in the field, in the north of Ireland, in quite recent years. The cultivation of it in Britain, however, even though it were fully permitted by law, would never become extensive, except perhaps for purposes of adulteration; for all tobacco grown here is deficient in the flavour, pungency, and narcotic power which characterise the tobacco grown in hot countries, and which constitute the main value of the plant, whether as a drug or as a popular and debasing luxury.

The methods of cultivation in different climates and countries are widely various; and that practised in France and Belgium, with the tongue-leaved variety of the Virginian species, and detailed in the *Journal d'Agriculture, d'Economie Rurale, et des Manufactures*, by Bailley St. Martin, inspector of tobacco manufactures in France, may be selected as the most instructive and interesting to British readers. The soil most suitable is of a marly, hot, and rather moist nature; and the manures most favourable are the sweepings of streets, the deposits of sewerage, and the ashes of strongly alkaline plants, such as those of artichokes, kidney-beans, ferns, beach, and buckwheat. The seed should be sown

on a slight hotbed in March; and one ounce will furnish plants for a plantation of an acre and a half in extent. The seed should not exceed two years old, and should be sown sufficiently thin to cover the surface of a bed 24 feet long and 4 feet broad. It may be steeped before sowing, and kept moist in a warm place till it begins to swell, in order to hasten its germination. Formerly, the tobacco beds were covered with straw instead of glass frames; but the plants were found to be too much etiolated, and therefore glass sashes and a frame, like that used for growing cucumbers, are recommended as decidedly preferable. Plenty of air is given at all times; and in fine weather, the sashes are removed during the day. About the beginning of May, and sometimes a fortnight earlier, the plants will have attained a sufficient size for transplanting; and a week before this operation commences, the bed should be left night and day without the frame and sashes. The tobacco is nearly as susceptible of injury from frost as the potato. The soil for the plantation should be deeply ploughed, well pulverised, and sufficiently manured. The plants may be placed in rows two feet apart, and two feet distant in the row: they should be watered, and, if convenient, a little litter laid round the root of each plant, to retain the moisture in the soil. It must never be forgotten that tobacco loves the sun and humidity; hence, besides keeping the ground clear of weeds, the plants are watered frequently during the months of June, July and August. After the plants have produced five or six leaves on the stem, they must be prevented from running to flower, by pinching out the heart of the main shoot, and rubbing off all the side shoots which are produced from it. Without this precaution, the principal part of the nourishment drawn up by the plants would go towards the formation of flowers and seeds, and the leaves would become thin and wither off. By shortening the main shoot, the whole of the nourishment is directed to the leaves, which thereby become strong and succulent, without any tendency to decay. Sometimes the plants are earthed up a little; but that operation is by no means essential. It is almost unnecessary to observe that, when seed is required, two or three vigorous plants are allowed to run to flower. When the seed is ripe, the plants are taken up, hung up in a dry airy situation, and afterwards the seed capsules taken off and preserved in paper till wanted. It is found that the seeds preserve much better when kept in the capsules than by any other means.

The following mode of gathering and saving the crop is described in the *Cours d'Agriculture Complet*, as practised in Alsatia and in France. The leaves are known to be fit for cutting when they have attained their full size, a dark green colour, and a brittle succulent texture. The lowest leaves acquire these properties first, and, in gardens or small plantations, are therefore first gathered, by being cut off with a knife close to the stem. Where tobacco is cultivated extensively, however, instead of gathering the leaves separately, the plants are cut over by the surface of the ground, and suspended under an open shed upon lines, so far apart that the leaves may not touch each other. In this state they remain till the leaves are perfectly dry, when they are stripped from the stalks, and tied in small bundles, a leaf serving for the tie. These bundles are laid in heaps in a shed, in order to bring on a similar degree of fermentation to what takes place in new hay. That this fermentation may equally pervade every part, the heaps are covered with a cloth, sometimes blankets, mats, or a layer of straw. These heaps are opened and spread abroad to the air from time to time, in order to prevent their overheating; and when this process has been carried on till no more heat is perceived in the heaps, the tobacco is fit for the manufacturer. But a considerably different mode is practised in America, and is described as follows by a writer in the Quarterly Journal of Agriculture: "The plant may be considered fully ripe when the leaves become corrugated and rough, and mottled with yellow spots on the raised parts, while the cavities between retain their original green colour. At this time they also become thicker, and the footstalks are covered with a downy velvet. If the weather be moderate, it is better to allow the plants to stand, until all these indications are apparent; but should frost come, they must be cut up, whether they are quite ripe or not. When the leaves begin to be corrugated, they must be nearly so. When quite ripe, the gatherer proceeds to the field on the first fine day; and, laying hold of the plant near the top with one hand, he cuts it over, with a large knife or axe, as near the root as possible, with the other. The stalk being severed, it is laid down with great care on the ground. The utmost gentleness must be used, in order to prevent the leaves, which are exceedingly tender and brittle, from being broken. The whole plants on the field being laid down, they are allowed to remain, during the rest of the day, exposed to the rays of the sun; and in the evening, they will be found quite pliant and flexible,—or, as the Americans call it, 'wilted.' Should the weather prove rainy, the operation of wilting must be allowed to go on under cover; but it is much more effectually done in the open air; and, on this account, the gathering ought never to be commenced unless the weather promises to be fine. In the evening, before sunset, when the leaves are completely wilted, and do not run so much risk of being broken, the plants are removed from the field into a large shed or house for the purpose, and laid in large heaps on the floor. When they have been in this situation about 24 hours, they will begin to ferment; and, when this operation is going on, they must be con-

stantly shifted, those on the top of the heap being put into the middle, and those in the middle on the top. During the fermenting, the leaves and stalks will assume a darker colour, and, if allowed to lie too long, will become mouldy, which must by no means be permitted. The process of fermenting may usually be allowed to continue three or four days, after which, the plants must be taken in pairs, and tied together at the roots, or have a peg run through their stalks, close to the bottom, and be suspended, in this way, with their leaves hanging down, with plenty of room between each pair, upon a cross-beam in the same shed. After the leaves are thoroughly dried, which they will in general be, after hanging about a month, the plants may be taken down. A damp day ought to be selected for this purpose, otherwise the leaves are apt, from their extreme dryness, to crumble into dust. But if the atmosphere be damp, their great affinity to moisture will prevent such a casualty. When down, they are again laid in heaps, and pressed together by large logs of wood. Fermentation will again commence, and may be allowed to continue about a week. Great care must be taken, however, to prevent the heat from becoming too great; and, in order to this, the person in attendance must constantly keep inserting his hand into the heap. When the heat exceeds a glowing warmth, it may be considered too powerful, and must be reduced by the removal of some of the wood. This second fermenting process, which in technical language is termed 'the second sweating,' is sometimes omitted; but both Bosc and Carver agree in recommending it, as it tends much to mellow the taste of the tobacco. It is generally allowed to continue for about a week, after which the plants are separated, and the leaves, being stripped off, are tied together in bunches, technically called 'hands.' This is the last operation performed by the planter, who sells the tobacco 'in hands' to the manufacturer."

The farmer who understands how to make good meadow-hay, will be at little loss how to make good tobacco. With regard to growing the plant, it requires very little more care than growing a crop of cabbages: the extra care is in raising the seedlings, pinching *out* the hearts, and *off* the side shoots, and gathering any caterpillars that may appear on the leaves. Any British farmer who contemplates a trial of the tobacco culture, and does not feel himself fully master of the subject, will find his difficulties easiest solved by applying to the nearest intelligent gardener, provided he be a reading gardener. But whoever understands the general principles of culture,—that is, whatever farmer is capable of reasoning on what passes under his notice in the culture of turnips and cabbages, and the making of hay,—is perfectly competent to cultivate tobacco.

The Properties, Uses, and Abuses of Tobacco.—Tobacco, whether applied externally or taken into the stomach, acts as a narcotic, a sedative, an emetic, a diuretic, and a cathartic; and when snuffed into the nostrils, it acts as a powerful errhine,—or when applied hot and in leaf to the skin, it is sufficiently irritating to raise blisters. Its narcotic and sedative actions operate on the heart through the medium of the nerves; and, whenever they are strong or excessive, they produce dreadful sickness, headache, extreme debility, cold sweats, and sometimes even convulsions, delirium, syncope, and death. The leaf is a remedial application for verminal sores; the smoke and the juice, through means of respectively the pipe and the quid, afford some relief from the paroxysms of spasmodic asthma; the powder, in the form of snuff, has the reputation of alleviating the evils of watchfulness and dim vision; the infusion and the smoke—the latter introduced by means of a peculiarly constructed pair of bellows—are sometimes efficacious in cases of ileus, suppression of urine, obstinate constipation, and incarcerated hernia, when other remedies fail; and the infusion, in minute and cautious doses, has occasionally been found serviceable, in cases of dropsy, dysury, and similar diseases, as an emetic and a diuretic,—but, in these capacities, is always a doubtful remedy and sometimes a very dangerous one. In veterinary medicine, enemas of tobacco are eminently serviceable in obstinate constipation, in tetanus, and in some bad spasmodic affections; and infusions of tobacco are common but very improper ingredients in external applications for mange and for destroying parasites.—In all its proper medicinal uses, tobacco ranks at best with such terrifically violent drugs as digitalis, belladonna, and prussic acid; and ought never to be employed by any inexperienced person in any case whatever, nor even by the most skilful practitioner except when feebler remedies are likely to be, or have actually been, inefficient.—Tobacco, in the several forms of smoke, infusion, and powder, is currently and extensively used in horticulture for destroying insects on plants; and, of course, it owes all its value in this way to its deadly power against animal life.

The proximate principle in which the narcotic energy of tobacco resides is an alkaloid called nicotina or nicotia. At thirteen degrees below the freezing-point, it appears as a slightly-tinged pulverulent matter; and above that temperature, it remains in the form of an almost colourless and transparent liquid, with a pricking and burning taste, which is so difficult to get rid of, that it is felt on the tongue for hours. The nicotina gives out, besides, a nauseous and pungent odour. It combines with the acids, with each of which it forms a salt. With a wick, it will burn like oil, diffusing a vivid light. It mixes readily with water in all proportions, and is soluble in alcohol, ether, and oil of almonds, but not in oil of turpentine. This principle of tobacco is so poi-

sonous, that a single drop of it will destroy a large dog. Besides its nicotina, tobacco contains ammonia, sugar, bitter extract, resin, albumen, potash, nitric and muriatic acids, and some other principles, the whole forming different combinations. The free ammonia appears a result of fermentation, and arises from the decomposition of hydrochlorate of ammonia, naturally residing in the plant. If a green tobacco-leaf be crushed between the fingers, it gives out no other than the herbaceous odour common to all plants; but if the same leaf be triturated in a mortar, with a small bit of quicklime, or a few drops of caustic solution of potash, it immediately yields the well-known odour of snuff. The reason of this is, that the lime or the potash decomposes the hydrochlorate of ammonia existing in the leaf, and liberates the ammonia; the hydrochloric acid flies to the lime or potash water, whilst the chlorine and the metal uniting, are converted into chloride of calcium, or chloride of potassium.

For the purposes of use and manufacture, the tobacconist spreads the fermented tobacco-leaves upon a stone pavement, and separates the bad from the good. This being done, the good leaves are watered, by successive layers one over the other, with a solution of common salt. They are then suffered to react upon each other during several days, according to their quality and the temperature to which they are exposed. At this period, a new fermentation arises, and more strongly develops the odorous principle of the leaf. The salt added to the tobacco is supposed to keep the leaf moist, and to temper the fermentative action, which might otherwise run into excess. The maintenance of moisture, however, is better effected by sea-water, which contains other salts besides common salt, or chloride of sodium, some of which have still a greater tendency than it to deliquesce. The leaves, after being thus prepared, are sorted and stripped of their middle stalk; when the larger are set by for making cigars, and the others, together with the stripped stalks, are appropriated for the manufacture of smoking-tobacco, chewing-tobacco, and snuff. "Most of the tobaccos on sale in our shops," observes Dr. Ure, "are mixtures of different growths. One kind of smoking-tobacco, for example, consists of seventy parts of Maryland, and thirty of meagre Virginia; and one kind of snuff consists of eighty parts of Virginia, and thirty parts of either Humesfort or Warwick. The Maryland is a very light tobacco, in thin yellow leaves; that of Virginia is in large brown leaves, unctuous and somewhat gluey on the surface, having a smell somewhat like the figs of Malaga; that of Havannah is in brownish, light leaves, of an agreeable and rather spicy smell,—it forms the best cigars. The Carolina tobacco is less unctuous than the Virginia; but in the United States, it ranks next to Maryland."

Beneficial as, in some cases, tobacco may prove in its character as a medicine, its use as a luxury, in any form, is as injurious as its intoxicating properties are lamentably demoralising. It is generally used in one, yet often in two, of the three forms of smoking tobacco, quid, and snuff. At the commencement, it causes, like opium, intoxication and sickness; but by continued use in moderation, these unpleasant symptoms subside into a sort of fascinating, dreamy state of semi-intoxication, which insidiously attacks the health, making disease and disorganisation creep by silent and stealthy steps into the system, and drink up the spring of life until its fountain is drained. An immoderate use of tobacco produces furious intoxication, and often dangerous delirium, much increased by the strong drinks which its stimulating properties incite the tobacco-consumer to take.

The most general of the three modes of using tobacco as a luxury is smoking. "Some seek in the inhalation of tobacco-smoke," observes Dr. Ure, "a pleasurable narcotism; others imagine it to be beneficial to their health; but, in general, smoking is merely a dreamy resource against ennui, which ere long becomes an indispensable stimulus. The filthiness of this habit, the offensive odour which persons under its influence emit from their mouth and clothes, the stupor it too often occasions, as well as the sallow complexion, black or carious teeth, and impaired digestion, all prove the great consumption of tobacco to be akin in evil influence upon mankind to the use of ardent spirits." Smoking in *any* form, and with *any* kind of tobacco, may, for a time, give ease to the solitary or the sedentary, most of whom are afflicted with dyspepsia; but by degrees it makes an inroad into the system which nothing can repair, and this, of necessity, by the very manner of its action. It maintains, even in its mildest form, the throat and its glands in a state of constant irritation, so as to excite unnatural thirst; it causes an excessive secretion of saliva, which is generally discharged, or, in more polite language, expectorated, and thus deprives the stomach of a fluid necessary to the deglutition and digestion of food, and robs the agents of digestion of a natural and necessary aid; it acts in such a manner on the brain as to produce loss of memory, and general deterioration of intellect; and, lastly, by its general action on the nerves, it generates not only depression of mind, but great infirmity of temper. We may add that, though for a short time it may prove a stimulus to the workings of genius, like the potent alcohol, it excites but to destroy; and many a highly-gifted smoker has survived the loss of that mind which rendered him the delight and ornament of his age and country. Every tobacco-smoker, too, has a tendency to become one of the most selfish and disagreeable of mortals; and though formerly urbane and benevolent, he may soon be a greater nuisance on the street than a hog right

from the sty, and with just as little apparent consciousness of the disgust and pain occasioned by his presence; or he may neglect all the proprieties and many of the highest moral obligations of the domestic circle, and feel utter indifference respecting them, simply that he may squander all the time and money which are due to them upon his own abominable propensity.

The quid is the next form in which tobacco is used as a luxury; and this is put into the mouth between the jaw and the cheek, and there rolled and sucked and turned and chewed. The kind of tobacco used for the quid is the strong leaf, prepared in the manner formerly described, and made first into cords and then into rolls, and popularly called pigtail. The quid in the mouth, like the smoke of tobacco, excites the salivary glands; and the mucus thereby secreted, mixes with the principle of the plant and forms a strong infusion of tobacco. Though this be discharged from the mouth, and little or none of it go into the stomach, the intoxicating and narcotic principle of the tobacco acts upon the brain, and causes the most dreadful intoxication in those unused to it. Like that of smoking, the habit of chewing tobacco is gradually acquired in the same manner as the taking of opium, and the madness of the intoxication gradually ceases; though most chewers of tobacco, unless actively employed, or enduring pain, are always in a state of semi-intoxication, not a few of them displaying an eye which very little would rouse into a glare of ferocious insanity; for it is the intoxication of tobacco that leads to the most cruel acts committed by the idle and the lawless. It is said, and it may be true, that men exposed, as sailors are, to be covered with wet clothes morning, noon, and night, require such a narcotic stimulus as tobacco, to secure them as well against intermittent fever and other distressing and dangerous complaints arising from their pursuits and necessary habits of life, as to keep up their strength and courage during the excessive muscular labour and trying hardships they have to endure. The same kind of stimulus may also be requisite in a low, damp country like Holland, and in climates such as those of the south-eastern coast of Madagascar and of Batavia. But of this we are certain, that, with very few exceptions, men exposed, from these causes or from any other, to the necessity of constantly using tobacco, run out more rapidly than others the thread of their existence,—and that the inveterate tobacco-chewer is as old in constitution at fifty years of age, as he would be at seventy, did he not use this seductive and dangerous plant.

The third form in which tobacco is used as a luxury is snuff. The practice of reducing this plant to a powder and preparing it for introduction into the nostrils, is general throughout Europe. It is said to have originated with the French; and indeed, it is very probable that no other nation in the world would have imagined so singular a mode of using the tobacco plant. As a remedial pretence is often assigned for smoking or chewing tobacco, so also is a similar excuse offered for snuff-taking. Persons who have sore eyes or bad sight are often recommended the use of this tobacco-powder; and it may have happened that inflamed eyes have been cured by such use; from which the takers have inferred that they must ever afterwards continue the practice, or the ophthalmia would return. But the snuff, in effecting such cure, had no peculiar specific virtue; its action was only that of a counter-irritant. The cephalic snuff, Grimstone's eye-snuff, or any other of the quack snuffs, sold as secret remedies for headaches and sore eyes, would have produced the same precise effect, and by the same precise means, but without the same injury to the constitution; for these contain no tobacco; they are composed principally of dried and pulverized sternutatory herbs, such as the leaves of the asarum, those of marjorum, and the flowers of the lily of the valley, combined. These, like the snuff of the tobacco plant, excite and irritate the mucous membrane of the nostrils, and cause an additional secretion of mucus, which accounts for the frequent use of the pocket-handkerchief by snuff-takers. But the tobacco snuff does more; it acts upon the brain, causing intoxication and sickness; and besides this, a large quantity of the powder taken into the nostrils enters the stomach, and there creates a truly distressing disturbance. Almost all snuffs, too, contain other matters besides tobacco; and though some contain nothing deleterious, and are only mixed with substances which improve their flavour, many are said to contain muriate of ammonia, pounded glass, carbonate of potash, and other matters intended to communicate pungency to the powder. To produce a certain ammoniacal flavour peculiar to many strong kinds of snuff, it is affirmed that human urine is sometimes employed; and from the odour of more than one variety, we cannot help thinking this affirmation correct. Pearlash, an impure carbonate of potash, is very frequently made use of by unprincipled dealers, to impart the pungency and flavour obtained in the best snuffs by more costly ingredients. "I was," says Dr. Ure, "employed some years ago by the excise to analyse a quantity of snuff, seized on suspicion of having been adulterated by the manufacturer. I found it to be largely drugged with pearlashes, and to be thereby rendered very pungent and absorbent of moisture,—an economical method of rendering an effete article at the same time active and aqueous." All the damaged or spoiled tobacco is converted into snuff, which, by the aid of adulterating ingredients and sonorous names, is sold at a high price. Thus, in spite of legislative enactments, a snuff-taker receives into his nostrils, and thence into his stomach, matters which, if he were but conscious that they formed component parts of his

favourite powder, would sicken him with disgust. And many of the most recherchés and fashionable snuffs are of this description. It is said that the human senses may be gradually brought to any degree of depravity; and in nothing is this more evident than in snuff-taking. Nauseous odours are considered delicious, and the vilest compounds, have they but a name, eulogised as most exquisite. There is a musty, overpowering, ammoniacal smell arising from snuff in large masses kept for years in close vessels; and this odious exhalation is one of the delights of the snuff-taker. Old snuff is, therefore, prized beyond measure; and what in any other vegetable production would render it only fit for the dunghill, is in snuff deemed its highest excellence.

TOCOCA. A small genus of ornamental, tropical, evergreen shrubs, of the melastoma family. Aublet's species, and the woolly, the former pinkish-flowered and the latter white-flowered, and both about 3 feet high, blooming in autumn, thriving best in a soil of peaty loam, and propagable from cuttings, have been introduced to the hothouses of Britain from respectively Guiana and Trinidad.

TOFIELDIA. A genus of curious and ornamental, evergreen, herbaceous plants, of the melanthium tribe. An indigenous species is noticed in the article Scotch Asphodel; four hardy species of from 2 to 6 inches in height, have been introduced to British collections from North America and Northern Europe; and several other species are known.

TOLPIS. A genus of ornamental, hardy, annual plants, of the succory division of the composite order. Five species, varying in height from 1 foot to 4 feet, and all thriving in any common soil, and carrying either yellow or yellow and purple flowers in June and July, have been introduced to Britain from Continental Europe.

TOLU (Balsam of). See Myroxylon.

TOMATO. See Love Apple.

TOMICUS. A genus of coleopterous insects of the bostrichidæ or wood-eating family. See the article Bostrichidæ. The antennæ of a tomicus cannot be folded under the eyes; the club is distinctly annulated; the head is rounded above and almost globular; the side of the thorax is emarginated; the tibiæ are not striated; the tarsi, at most, are as long as the tibiæ; the eyes are elongated and somewhat emarginated; and the body is cylindrical. Eleven species are known to inhabit Britain; all frequent coniferous trees of the pine and fir family; and some occasionally commit great devastations in other countries; but none are recorded to have done any considerable mischief in Britain. The printing species, *Tomicus typographus*, so called from the letterpress-like traces which are made by its tubular bores or paths, is a rare insect in Britain, but abounds in many continental countries, and has there won a bad fame by its havoc upon forests. It is popularly known in Germany under the name of the Turk; and is recorded to have appeared in prodigious multitudes in the Hartz pine forests in the years 1757, 1769, and 1783,—and to have, in the last of these years, destroyed not fewer than a million and a half of trees, and occasioned a disastrous falling off in the supply of fuel throughout the circumjacent country.

TONGUE. The muscular organ which, in man, forms the principal articulations of speech, and which, both in man and in the inferior animals, disposes the food for mastication between the grinders, collects it after mastication, forms it with the aid of the bars of the palate into pellets for deglutition, and serves as the main instrument and canal for the imbibition of drink. The tongue of some particular groups or orders of animals also performs some additional functions; and that of all co-operates with the palate in exercising the sense of taste. Every tongue is muscular; and that of the higher orders of animals comprises a vast number of fibres, arranged in various forms and directions, interspersed with a considerable quantity of fatty matter, covered with a curious, triplicate, fleshy envelope, and comprising a multitude of minute, comprehensive, and perfect adaptations to its various offices; and that of man, in addition, possesses such ramifications of nerves, such intricacies of mechanism, and such a thousandfold power and nicety and volubility of action in subserviency to the purposes of speech, as render it an absolute museum of most instructive wonders. The tongues of oxen and horses are alike held firm in their places by muscular attachment to the *os hyoides*, a singular bone which connects the whole lingual organ with the larynx; but the ox's tongue needs to collect the herbage in grazing, to roll back the gathered herbage into the mouth, to clean the muzzle from dirt and insects, and to wipe away accumulations of morbid discharge from the nostrils, and therefore has a very loose root of attachment, and possesses very great freedom of motion, and can be far and volubly protruded out of the mouth; while the horse's tongue needs not to perform any such extra functions, and requires capacity to withstand the restraints and abrasions of the bit, and therefore has a very radical attachment, and possesses a sort of pad on which the bit may rest, and is rarely protruded at all from the mouth, except when the vicious habit is acquired of licking the manger. Two bad diseases of the tongue of cattle and sheep are noticed in the articles Blain and Aphthæ. A severe laceration or even disseverment of the tongue of the horse is sometimes occasioned by the awkward manner of administering a ball; but, in general, may soon be alleviated or cured by means of syringing with a solution of alum. A series of purplish vesicles sometimes forms along the under side of the horse's tongue, and occasions enlargement of the whole organ, the copious secretion of a ropy

saliva, and great difficulty or even impossibility of deglutition; and they must be lanced freely and deeply, and a little cooling medicine given to subdue accompanying or resulting symptomatic fever.

TONIC. A medicine which increases the digestive power of an enfeebled stomach, and in consequence improves the general strength of a debilitated body. The best tonic, in any case of sound constitution which has merely been temporarily invaded by an acute disease, is to let the system completely alone after the disease is subdued, or at best to use a little care in the selection of food. Tonic drugs, like cordials, are very good in their way, and often do great and rapid service, but are exceedingly liable to be abused, and sometimes serve as very mischievous tools in the hands of hasty or unskilful practitioners. In veterinary medicine, such mild tonics as chamomile, gentian, and ginger are the most useful, and the least likely to do harm, in all ordinary cases; such stronger tonics as cinchona, quinine, oak-bark, gentian, quassia, cascarilla, and carbonate of iron, require some more caution and discrimination in their use; and such mighty and violent tonics as preparations of copper, zinc, mercury, and arsenic are suitable only in very particular cases, and ought never to be used at all except by the most intelligent practitioner and after the most careful consideration.

TONQUIN BEAN. The seed of *Dipterix odorata*, well known to snuff-takers for the use which is made of it in perfuming their nose-powder. The *Dipterix odorata* is a tropical, purple-flowered, evergreen tree, belonging to the cæsalpinia division of the leguminous order, and naturally attaining a height of about 60 or 70 feet. It was introduced from Guiana to the hothouse collections of Britain about 56 years ago; and it thrives best in a soil of rich peaty loam, and is propagable from cuttings.

TONSELLA. A genus of ornamental tropical plants, of the hippocratea tribe. Two species, the climbing and the pear-shaped, both green-flowered, evergreen climbers of between 5 and 8 feet in height, have been introduced to British hothouses from Guiana; and eight or nine other species are known.

TOOTH. See Teeth.

TOOTHACHE-TREE,—botanically *Zanthoxylum*. A genus of ornamental, ligneous, exotic plants, of the rue family. The Hercules' club species, *Zanthoxylum Clava-Herculis*, is the species best known in Britain, and that which originally received the name of toothache-tree,—a circumstance which it owed to the reputation of its bark as a cure for toothache. See the article Hercules' Club. The height of this shrub is commonly 10 or 12 feet; the bark is rough, and armed with short thick spines; the leaves grow without order on the branches, and are pinnated in form, and of a fine dark green colour on their upper surface, and yellowish underneath, and have a highly ornate appearance, and present a general resemblance to those of the mastic-tree; the folioles of each leaf amount to four or five pairs and a terminating odd one, and have an elongated lanceolate form; and the flowers come out in loose panicles from the ends of the branches, and are small and inconspicuous, and are succeeded by roundish capsules. This plant loves a soil of rich peaty loam, and is propagable from cuttings.—The ash-like, the three-capsuled, and the mild species, *Z. fraxinium*, *Z. tricarpum*, and *Z. mite*, are hardy deciduous shrubs, the first and second about 6 feet high and the third about 10 feet high, introduced from North America at various periods since about the middle of last century; and are best propagated from layers.—Ten or eleven tropical and subtropical evergreen species, varying in natural height from 10 to 25 feet, and mostly loving a soil of rich peaty loam and propagable from cuttings, have been introduced principally from the two Indies; and about thirty other species are known.—A large number of the species, and probably all, possess in a greater or less degree acrid, stimulating, and tonic properties. The Hercules' club and the ash-like—which some persons regard as only very distinct varieties of one species—have the reputation in America of being powerfully sudorific and diaphoretic, and excite copious salivation, not only when made to act directly on the mouth, but when taken internally, and have been found highly efficacious in paralysis of the muscles of the mouth; and the Caribbean species, *Z. caribæum*, is regarded in Guiana as a cleansing vulnerary and a febrifuge.

TOOTH-TONGUE. See Odontoglossum.

TOOTHWORT,—botanically *Lathræa*. A small genus of curious plants, of the orobanche tribe. The scaly species, *Lathræa squamaria*, is a perennial-rooted, epiphytous indigen of dry shady spots, at the root-crowns of elms, beeches, hazels, and other trees, in the woods and thickets of many parts of Britain. It is about a foot high; and has white fleshy scales instead of leaves; and carries herbaceous-coloured flowers in April. It is exceedingly shy of cultivation; but may be brought into a rhododendron quarter by removal of the whole plant, together with as much as possible of the adhering soil, from a spot where it naturally grows; and may afterwards be propagated by a careful division of the roots.

TOP-DRESSING. A manure of any kind spread upon ploughed land without being turned in, or a fine, or comminuted or thoroughly reduced or special manure sown or equally distributed upon grass land. Common kinds of top-dressings are soot, ashes, rape-dust, gypsum, common salt, and the nitrates of soda and potash. See the article Manure.

TORDYLIUM. See Hartwort.

TORE. Rowen or winter-grass. See the article Aftergrass.

TORENIA. A genus of curious and ornamen-

tal exotic plants, of the figwort family. The rough-leaved species, *T. scabra*, is a handsome, evergreen shrub of about 3 feet in height, carrying pale blue flowers from June till August; and was introduced to the greenhouses of Britain from Moreton Bay in 1830; and loves a soil of rich loam, and is propagable from cuttings. The heart-leaved species, *T. cordifolia*, is a curious, late-blooming, pale-lilac-flowered, tender annual, of about 6 inches in height; and was introduced in 1838. Two tropical, purple-flowered, July-blooming, evergreen trailers also occur in British collections; and one of these, *T. asiatica*, is used on the Malabar coast as a medicinal plant.

TORILIS. See HEDGE-PARSLEY.

TORMENTIL. See SEPTFOIL.

TORTRIX. A genus of moths, constituting the type of the family Tortricidæ. The insects of this family are comparatively small and prettily coloured; and possess a bad fame among foresters for the destructive habits of their caterpillars among the foliage of trees. Their proboscis is distinct; their inferior palpi are closely similar to those of the most typal forms of phalenæ; their wings are tectiform, but almost horizontally flattened, and always laid on the body; their upper wings are arcuated at the base of the exterior margin, and then narrowed; and their figure is short and wide, and forms a truncated oval, and gives the insects a very peculiar appearance. The caterpillars have sixteen feet, and a closely shorn or but slightly pilose body; and most twist and roll up the leaves of trees, and connect various points of their surface at different times by layers of silken threads running in one direction, so as to form tubes,—and in these they reside, feeding tranquilly on the parenchyma; but others form a nest by connecting several leaves or flowers with silken threads; and a few inhabit fruits. Some of the species best known in Britain, or most remarkable for their depredations, are the pea-green moth, *Tortrix viridana*, which infests the leaves of the oak-tree,—the rose moth, *Lozotœnia rosana*, which infests the flower-buds of rose and currant bushes,—the narrow-winged red-bar, *Ditula angustiora*, which rolls up the leaves and destroys the nascent fruit-buds of the apricot-tree,—the apple or codling moth, *Carpocapsa pomonella*, which eats into the pulp and devours the pips of growing apples,—the Wœberian moth, *Carpocapsa Wœberiana*, which feeds on the bark of various kinds of fruit trees,—the Bergmann rose moth, *Argyrotoza Bergmanniana*, which devastates the foliage and mutilates the flower-buds of rose plants,—the turpentine moth, *Cnephesia resinella*, which works havoc on the young shoots of fir-trees,—and the bud-tortrix of the pine, *Argyrolepia turionella*, which infests and devastates the buds of young abietinous trees, particularly silver firs.

TOUCH-ME-NOT. See IMPATIENS.

TOURNEFORTIA. A genus of ornamental, evergreen, exotic plants, of the borage family. About a dozen species, principally evergreen shrubs of from 2 to 10 feet in height, have been introduced to the conservatories, greenhouses, and hothouses of Britain; and about 30 other species are known. One of the earliest introduced is described as follows by Miller, and may serve as a sufficient specimen of the whole. "It grows naturally in Jamaica and in some other islands in the West Indies. It rises with shrubby stalks 8 or 10 feet high, sending out many branches, closely garnished with oval spear-shaped leaves placed alternately round the stalks. These are 5 inches long, and 2½ broad in the middle, hairy on their under side, and stand on short footstalks. The branches are terminated by long branching spikes of flowers, ranged on one side the footstalks in the same manner as those of the heliotrope. Some of the footstalks sustain two, others three, and some four spikes of flowers, which are near 5 inches long, and are reflexed like a scorpion's tail at the top. The flowers are of a dirty white colour, and are small and closely ranged on one side of the spike; and are succeeded by small succulent fruit, enclosing four oblong seeds in each." Nearly all the introduced species thrive best in a soil of peaty loam, and are propagated from cuttings.

TOWER-MUSTARD,—botanically *Turritis*. A small genus of white-flowered herbaceous plants, of the cruciferous order. The smooth or long-podded tower-mustard, *Turritis glabra*, called by some botanists *Arabis perfoliata*, is an annual indigen of grassy-banks, road-sides, and pasture fields, with a dry gravelly soil, in various parts of England. Its root is tapering; its stem is erect, slender, leafy, and from 15 to 36 inches high; its radical leaves are numerous, spreading, toothed, and rough; its cauline leaves are sheathing, oblong, arrow-shaped, entire, glaucous, and smooth, and are so disposed on the stem as to present a pyramidal or tower-like appearance, which is alluded to in both the popular and the botanical names of the genus; the flowers are numerous, and grow in close corymbs, and bloom in May and June; and the pods stand on short footstalks, and are very long and slender, and contain about sixty very small seeds in each cell.

TOWER-MUSTARD (WALL-CRESS),—botanically *Arabis turrita*. An indigenous biennial plant, of the wall-cress genus and cruciferous order. It grows on walls and similar situations in some parts of England; and has a general appearance similar to that of the smooth tower-mustard. Its stem is commonly about 18 or 20 inches high; its cauline leaves are clasping; its flowers are sulphur-coloured, and bloom in April and May; and its seeds are marginate. Two varieties of it, called the shady and the pendulous, have been introduced to British botanical collections from Continental Europe.

TOXICODENDRON. See SUMACH.

TRACES. See DRAUGHT, PLOUGH, CART, and TRACTION.

TRACHEA. See WINDPIPE.

TRACHELIUM. See THROATWORT.

TRACHEOTOMY. The formation of an artificial opening into the windpipe. It is sometimes required, in horses, in cases of strangles, of throat-tumours, and of excessive tumefaction of the mouth and nostrils, arising from the effects of severe accidents,—in cattle, in cases of blain, of inflammation of the parotid gland, and peculiar tumours arising from fever,—and both in horses and cattle, in cases of threatened suffocation from the pressure of some large piece of food or other substance sticking fast in the œsophagus. "The operation," says Delabere Blaine, with special reference to horses, "is a very simple one, and may consist either in a longitudinal section made through two or three of the rings; or a portion, occupying about an inch square, may be excised from the anterior cartilaginous substance, and which latter is by far the best method. The integuments should be first divided in front of the neck three or four inches below the obstruction; and the integumental section should be sufficiently long to allow of their being retained back by a hook to each side, to which tape should be attached and tied on the crest of the neck above. This is however only to be pursued when the obstruction is likely to remain but a few days. When a more lengthened one is probable, a tube adapted to the size of the trachea must be introduced, having an acute turn and a projecting rim, which must furnish holes for the adaptation of tapes to secure it around the neck."

TRACHYMENE. A genus of curious and ornamental, exotic, evergreen shrubs and undershrubs of the umbelliferous order. Four or five species have been introduced to the gardens of Britain, principally from Australia; and all love a soil of sandy peat, and are propagated from cuttings. The name trachymene signifies 'a rough membrane,' and alludes to the involucrum.

TRADESCANTIA. See SPIDERWORT.

TRAGACANTH. A medicinal gum, supposed to be produced by the great goat's thorn, *Astragalus tragacantha*, a hardy evergreen undershrub, belonging to the lotus division of leguminosæ, and introduced to the gardens of Britain from the Levant in the year 1640. The stem of this plant is about an inch thick, very much branched, and about 2 or 3 feet high; the branches are closely crowded together, and have an armature of scales and spikes, formed from the petioles of the preceding year; the leaves are pinnate, each comprising six, seven, or eight pairs of leaflets, and scarcely half an inch in length, and terminating at the end of the midrib in a sharp yellowish point; the leaflets are opposite, villous, stiff, and pointed; and the flowers grow from the axils of the leaves, and are small, pale yellow, and papilionaceous, and bloom from May till July. The gum exudes in tortuous filaments during the heat of summer, and is allowed to dry on the plants before it is gathered; and it is produced principally in Persia, and sent thence to Britain by way of Aleppo. It is whitish, semi-transparent, brittle, difficult of pulverisation, inodorous, and very slightly bitter. It swells and softens in water, but cannot without special management be reduced in even a small degree to the state of mucilage; and it is insoluble also in alcohol and ether. It possesses demulcent properties; and is employed, in a compounded or pharmacised form, in cases of catarrh, hectic fever, strangury, and dysentery.

TRAGIA. A genus of exotic, green-flowered plants, of the spurge family. Nearly a dozen species—comprising annuals, perennials, twiners, creepers, and erect plants, varying in height from 1 foot to 6 feet, some hardy, others very tender, and most capable of thriving in any common soil—have been introduced to the botanical collections of Britain; and about as many more are known.

TRAGIUM. A genus of exotic, white-flowered, herbaceous plants, of the umbelliferous order. The anise plant, *Pimpinella anisum* or *Sison anisum*, is assigned in the most modern botanical rearrangements to this genus. See the article ANISE. Six other species, principally perennial-rooted, annual-stemmed, and about two feet high, have been introduced to Britain; and three or four more are known. The name tragium is formed from a word signifying a goat, and alludes to the hircine odour of the oldest-known species.

TRAGOPOGON. See GOAT'S BEARD.

TRAGOPYRUM. See GOAT'S WHEAT.

TRAINING. See BREAKING and MANEGE.

TRAINING, IN GARDENING. Towards the end of March, young trees that have been planted out since October of the former year are headed down, or have their shoots shortened back to three, five, or six buds, according to their strength, and the purpose for which they are intended. When the trees have stood two, three, or more years in the nursery after grafting or budding, the heading down is of course confined to the last year's shoots, and its extent, as well as the thinning out of superfluous shoots, must be left to the judgment of the experienced gardener, it being impossible to lay down rules where the circumstances must be perpetually varying.

Wall-trees.—The two principal methods of training wall-trees which are followed in this country, are called the *fan* and the *horizontal* modes. In the former, the branches are arranged like the spokes of a fan, or like the hand opened and the fingers spread. In the other way, a principal stem is carried upright, and branches are led from it horizontally on either side. The Dutch style consists in taking a young tree with two branches, and leading these horizontally to the right and left, to the extent perhaps of

twelve feet each way, and in then training the shoots from these perfectly upright to the top of the wall. This is now seldom practised here, excepting perhaps with fig-trees or white currants. In some places, a few of the wall-trees are trained in a stellate form, the stem being led upright for about six feet, and then some branches trained downwards, others laterally, and others upwards. When walls exceed seven feet in height, the best gardeners seem to concur in giving the preference to the fan training, variously modified: in this way they find that a tree can much sooner be brought to fill its allotted space, and the loss of a branch can much more easily be supplied at any time. For lower walls, the horizontal method is preferred; and the same plan is adopted almost universally on espalier rails. Mr. Hitt strongly recommends this mode for most sorts of wall-trees; and for pears he adopts what is called the *screw* stem, or training the stem in a serpentine manner, the branches going off horizontally as in the ordinary straight stem.

In the first volume of the Transactions of the London Horticultural Society, Mr. Knight has made some ingenious and excellent remarks on the training and pruning of fruit-trees. His year-old plants are headed down as usual, early in the spring, and two shoots only are trained from each stem in opposite directions, and to an elevation of about 5°. To procure the shoots to be of equal lengths, the stronger is depressed, or the weaker elevated. All lateral shoots are destroyed. Thus far, it may be remarked, Mr. Knight's method agrees very much with Hitt's, described in his treatise on fruit-trees. This shape, Mr. Knight observes, ought to be given to young trees in the nursery, and is perhaps the only one that can be given to them without the risk of subsequent injury. Next season, as many branches are suffered to spring from each plant as can be conveniently trained, without shading each other; and by selecting the strongest and earliest buds towards the points of the year-old branches, to be trained lowest, and the weakest and latest near their bases, to be trained inclining upwards, each annual shoot will be nearly equal in vigour. In the following winter, the shoots are alternately shortened and left at full length. In the course of the third year, if the tree be a peach, the central part consists of bearing wood: and, upon the whole, the size and general health of the trees trained in this way, afford evidence of a more regular distribution of the sap than Mr. Knight has witnessed in any other mode.

The distance at which the branches are laid in, in all the different modes, varies from eight to ten inches, according to the nature of the tree, or the size of its foliage or fruit. While fan-trained trees are still in progress, a few more shoots are preserved at the summer pruning, than are likely to be ultimately laid in; this is for fear of accidents. Trees that have filled the spaces allotted to them, are disbudded of most of the wood-buds that appear. Wood-buds on old spurs are always displaced. Trees which are in training for the horizontal method require different management. The leading stem is constantly to be attended to; all the buds that appear on it are carefully preserved, till enough be procured to lay right and left, and form the tree. All wood-buds on the horizontal branches, excepting the leading one, are displaced. The fan-training is considered as best for apricots, cherries, and plums, placed against walls, even though the walls be low. None of these kinds of fruit answer well for espaliers; cherries or plums succeed better as half standards or dwarf standards.

The wall-trees which have now been spoken of are called *dwarfs* by the gardeners. It is a very common practice to train high standards on the intermediate spaces between the dwarf trees; such trees are in Scotland termed *riders*. Plants four or five years old are preferred, because they are but temporary, and the object is to get fruit as soon as possible. Some good judges have condemned this plan of temporary trees as hurtful; being calculated to deprive the permanent trees of a proportion of the nourishment which they would otherwise draw from the border; but if the border be tolerably rich, and be only slightly cropped with herbaceous plants, it does not seem likely that the temporary trees can do much injury.

Espalier Trees.—Some horticulturists have proposed to banish espalier-trees altogether, alleging that they injure the kitchen-garden quarters, by depriving them of sun and air. But though they are sometimes injurious by depriving the plants of air, they are at other times very useful, acting as a hedge in protecting the young crops from the violence of strong winds. Espalier-trees generally produce excellent fruit, the sun and air having access to both sides of the tree; they commonly afford abundant crops, and the fruit is not apt to be shaken by high winds. Further, they tend to hide the crops of culinary vegetables from the eye, and to render the walk of the kitchen garden as pleasant as an avenue in the shrubbery. Apples and pears are the fruits best suited for espaliers. The apples are generally grafted on crab stocks, to keep them of moderate size; or, if the tree be wished still smaller, on Dutch paradise stocks. The distance allowed between the former is from 30 to 40 feet; between the latter, 25 is found sufficient. These may seem large spaces at first; and, to take away the naked appearance, a small cherry-tree, or white currant bush, is sometimes planted in each interval. It is to be studied that, in the same line of rail, trees of similar growth be planted; so that the whole may be nearly equally filled. The trees, when planted, should be of one year's growth, or at most of two years. If the rail be not previously erected, so that the branches can be tied

to it, a stake is necessary, to prevent wind-waving. Very often, the permanent rails are not put up till the trees have been two or three years trained on temporary stakes. Simple ash-poles firmly stuck in the ground, and either charred or smeared with tar at the bottom, to retard rotting, form a very efficient substitute for a rail; for it is to be observed, that during summer, when the leaves are expanded, they equally hide the roughest poles, or the most finished rail. Mr. Nicol, however, recommends sinking hewn stones in the earth, and fixing a wooden rail in them; and a writer in the Scottish Horticultural Memoirs, vol. i., has described a kind of cast-iron espalier rail, which of course must be highly durable, and, what is remarkable, is cheaper at the first than a wooden one. Some gardeners shorten the head of the tree in the usual way; others preserve the original branches at full length, never cutting a branch unless where there is a real deficiency of wood for filling the rail. The pruning is chiefly done by disbudding in the summer season. The distance at which the branches are laid in depends on the size of the fruit and leaves; when these are large, seven or eight inches are required; when small, four or five may be sufficient. See the article ESPALIER.

Dwarf Standards.—Dwarf trees were formerly much in vogue; and, strange as it may appear, the prospect of fruit was generally sacrificed to a fine shape. It was thought necessary that the lower branches should spread horizontally near the ground, and should decrease in width upwards, so that the tree should have a conical form. Now, it is well known that the fruit-buds of pears and apples in general, and of many sorts of plums and cherries, are produced at the end of the former year's shoots, which therefore should remain at full length; yet these were necessarily shortened, in order to preserve the desired shape, and it may easily be conceived that trees so dressed could not prove fruitful. For these reasons, the training to espalier-rails has generally been preferred. A few dwarf trees, however, prove ornamental, and they sometimes afford a great deal of fruit. The kinds of dwarf fruit-trees now in request are chiefly pears and apples. The pears must be of the summer and autumn sorts, the later fruits requiring a wall in our climate. Dwarf pears are chiefly budded on quince stocks. The trees are planted out, at two or three years old, where they are to remain, and they are placed from 20 to 25 feet asunder. A few stakes are driven into the ground, and, by means of tying down, the lower branches may soon be made to acquire a horizontal direction. No branches must cross each other, and no central upright shoots are permitted. The only other particular to be attended to is, when the trees are to be trained in a concave form, that, in shortening the shoots, the uppermost eye or bud is to be left *outwards*, as in this way the hollowness in the middle of the tree is better preserved. Sometimes the branches are trained round a hoop, which is supported by three or four small poles. Dwarf standard apple-trees on paradise stocks may be planted very closely, as they occupy but little room: they do not require more than 10 or 15 feet; on crab stocks they need at least 25. Plums are now seldom planted as dwarf standards; cherries more frequently; apricots scarcely ever.

TRAMMEL. An artificial hindrance to the free motion of an animal's limbs,—particularly an implement of leather or of ropes, fitted to a horse's legs to restrain his natural paces, and to aid the purposes of the manege.

TRANSPLANTING. The removal of a living plant from one site to another. This must be done without any material damage to the roots; else the plant will suffer in health, or even may die. Generally speaking, there is no difficulty in removing plants when young; and if they were removed every season, they would hardly be the worse for it. When, however, we attempt to remove trees, plants, or shrubs, that have been many years undisturbed, the greatest care must be used to prevent injury from the loss of fibres, which, with all our attention, will be broken. Two facts may be relied upon in the consideration of this subject,—first, the growth of a tree is always in proportion to the under-growth of its roots, and the head maintained grows as large as the roots will allow it; and second, any damage the roots sustain checks the growth of the tree or plant. From these two facts all the art of removing trees and plants should be learned; and upon these two facts all the art is founded. In transplanting seedlings of almost any kind, there is no difficulty, because the roots being easily removed whole, the plants suffer nothing. In seedlings of all kinds, there is a strong disposition to make new roots; and, if the fibres are damaged, but little mischief accrues. It is when plants have stood some time, and their roots have made considerable progress, that the difficulty of removal begins to arise. Here, then, we have two particular duties to perform; the first is, by carefully removing the earth to the very end of the root, to get the plant up with as little damage as possible; and the second is to curtail the head sufficiently to allow for the damaged powers of the root. In taking up nursery plants, where despatch governs every thing, the roots lose considerably, and the ends of all the main spreading portions are invariably chopped off with the spade. In this case two other operations become necessary,—first, to cut smooth all the bruised ends, and, second, to prune off a considerable portion of the branches, in order to diminish the evaporation and consumption of moisture. Some trees, indeed, are so much inclined to grow and strike root, that they would live almost if the roots were chopped off; but others are extremely impatient of damage at the

roots, and, if not very carefully removed, will fail. Again, there are many trees that cannot be pruned; for instance, cedars, firs, arborvitæ, and trees of that description, must not lose a branch, or they lose their beauty. Hence the necessity of removing every fibre of the root with it, if the tree is to live. But the more valuable kinds are generally kept in pots a few years, that they may suffer nothing by removal. As they advance in growth, the pots are changed; but at length they are turned out into the ground,—and for one year, or even two, they might be moved well and easily, because their roots have not had time to spread; but, after that, the difficulty increases every year, and it is a tedious as well as troublesome task to follow out the direction of the roots, and extricate them from the ground without damage.

The only conditions required on removing a tree of any age or kind are, first, to release all the root from the ground, without bruising; secondly, to remove the tree whole, as it is, and undamaged, from where it was to where it is to be; thirdly, to preserve all the fibres thoroughly moist, from the time it is released from the ground until it is replaced; fourthly, to support it in such way, on replanting, as that the earth may be all among the fibres and roots, solid and proper, as it was when it was moved; and, lastly, so to tread and press the earth about it that the fibres shall not be pressed together, nor the roots bent out of their places. It is next to impossible, however, to comply with all these conditions with very large trees; and therefore large trees are seldom removed, and rarely live after removal. Many contrivances have been resorted to; but there ought to be two years' preparation before it is attempted. This preparation consists of digging a circle round the tree, and cutting off the roots that extend beyond; and as even this may be too much check, if all done at once, it is necessary to do it at two different periods, by opening four opposite places, and at each place cutting away an eighth of the circle, building a wall within a foot of the remaining roots, and filling up that foot with the soil again, as well as the hole outside the bricks. New fibres and roots will spring out, and almost fill the space to the bricks. The next season the other four spaces may be opened, and the roots cut off at the same distance. At this time there must be some undermining, to examine whether there be any roots running very deep or downwards, like a tap-root; and if there be any, they must be severed before you build walling to complete the circle of bricks. If these operations be well conducted, there will, by the next moving time, be a mass of roots within the brick wall capable of sustaining the tree; and the removal, without damage, will be accomplished with little risk. The only thing then required is power; for by clearing all round the outer part of the brick wall first, and then pulling it down, the roots will be undamaged, and the ball of earth entire. But too much importance is attached to the mere ball of earth in all cases. Thousands of trees have been moved with balls of earth to them five times the weight of the trees themselves, while the roots have been dreadfully shortened all round, and the principal nourishing portions removed. In removing very large specimens, some nicety is required in reducing the head enough to make allowance for the decreased power of the roots, without injuring the general figure and appearance. Even in adopting the plan we have suggested, which is too troublesome for anything but a really valuable and large specimen, the head of the tree should lose something, and it will require some ingenuity to remove those portions whose removal will not injure the appearance of the specimen. But the same principles that govern us in the case of a large tree should be observed in transplanting all things.

One certain fact is, that whatever the root suffers checks the tree, and unless the subject be the better for checking, the plant must be reduced, and therefore care must be taken to prevent the root from suffering. But many subjects are the better for the check,—that is to say, they would be too luxuriant without such check; hence the practice of root-pruning, to check fruit-trees,—a practice that hastens maturity and brings on fruit-bearing. This was the inducement to disroot pines, which some people have complained of as unnatural culture. The pruning of roots checks the flow of raw sap, which induces rank growth, and allows that already in the tree to elaborate and adapt itself to the fruiting process; and if roots are not pruned, or a check given artificially, the tree must push on with vigour, forming leaves and branches, but no fruit, until the tree attains its mature size, and the roots have settled down the supply by lessening it sufficiently, when that sap which is supplied will properly elaborate, and fruit is the consequence. Confine the roots of a tree in a pot, and stunted growth is a certain consequence. Cut away the parts of a root which wander farthest, and a more sudden check takes place; yet it so lessens the quantity of nourishment taken up, that, if it be not too violent, it hastens the blooming and fruiting. Carry this operation too far, and the check is too great; yet a little further, and the tree dies, because the leaves give off more moisture than can be taken up. The only chance, therefore, of saving trees of which the roots have been too much damaged, is to lessen the work which the roots have to perform, when the life will be saved. Plant unchanged such trees or shrubs as have accidentally or otherwise been deprived of one half or so of their roots in the process of taking them up, and they die; lessen the head a good deal, and they live, but are sickly; cut a very large portion down, and the remainder will not

lose a leaf. Hence it is that plants of all kinds which are inclined to grow too vigorously receive a wholesome check when they are young; that fruit-trees are root-pruned, and bear the earlier for it; that pine-apples are disrooted to hasten their fruiting; and that many plants which are apt to run away and grow too fast are frequently removed, and each time with the loss of some of their roots. See the article PLANTING.

TRAP. See the articles MOUSE, RAT, and VERMIN.

TRAPA. See CALTROPS (WATER).

TRAP-ROCKS. An important class of rocks in geology, which derive their name from the Swedish word *trappa*, a stair, because they frequently divide into regular forms, resembling the steps of stairs.

These rocks vary in texture, from an apparently simple rock to a confusedly crystalline compound, in which crystals of felspar are disseminated. The predominant substance in the members of the family is a simple rock, of which indurated clay (wacke) may be placed at one extreme, and compact felspar at the other, the intermediate members being claystone or clinkstone. In some cases, it forms the whole mass; in others, it is mixed with other materials in various proportions, producing great diversities of aspect, without any material variations in the fundamental character. It often appears as if quartz, felspar, and hornblende composed the mass, and various circumstances determined their union in such a manner as to produce a large proportion of the different compounds known as trap-rocks, sometimes the hornblende being in mass, at others the felspar, while the quartz rarely predominates. In other situations, confusedly crystalline compounds have been the result. Quartz, felspar, and hornblende united form *sienite;* or felspar and hornblende, without the quartz, constitute *greenstone.* The compounds occasionally contain disseminated crystals of felspar, and thus become what are called *greenstone porphyries* (*diabase porphyroide,* French; *Grunstein Porphyr,* German). A paste of green hornblende, containing crystals of felspar, constitutes the *antique green porphyry* (the *ophite* of the French). Some of the trappean rocks are often vesicular, in the manner of modern lavas; the vesicles, however, being generally filled up by some mineral substances, which have been infiltrated into them subsequent to their formation. Such substances are either agates, calcareous spar, or some of the zeolitic minerals. From these cavities frequently being of an almond shape, or rather from the appearance of their solid contents resembling almonds in form, the term *amygdaloid* has been applied to rocks of this description. It must be understood that the base, or paste of the amygdaloids, is not constantly the same, but is liable to vary materially. A trap-rock is sometimes both amygdaloidal and porphyritic at the same time. Other minerals besides those above enumerated occur in the trappean rocks, but cannot be considered as forming an essential part of them, with the exception of augite and hypersthene, which, with the mixture of either common compact or glassy felspar, constitute the *augite* and *hypersthene rocks.*

It would be inappropriate to the present article to attempt a notice of the various aspects under which these rocks present themselves. It should, however, be remarked, that the term *basalt* is applied to substances which are not precisely the same, being sometimes given to a fine compound of augite and compact felspar; at others, to a minute mixture of hornblende and compact felspar; sometimes to dark, indurated claystones, and finally to a compound of felspar, augite, and titaniferous iron. The last mixture seems that now most commonly termed *basalt.* Basalt is possessed of a greenish, or brownish, and sometimes of an iron-black, colour. It is difficult to break, and possesses a considerable degree of hardness. It is fusible into a black glass, and is magnetic. The iron which it contains, as is the fact also with greenstone, passes, when exposed to the air, into a further state of oxygenation; and they are consequently generally covered with a reddish-brown incrustation. —The whole family of trap-rocks have, on the one hand, a close alliance with volcanic rocks, and, on the other, with the more ancient rocks of porphyry and granite. The gradation of trap-rock, having in some parts a volcanic character, into true granite, has been observed in a mountain near Christiania, in Norway. The lower rocks are gneiss, over which occurs dark slate, in which are beds of blackish limestone, containing organic remains. These beds are covered by an enormous mass of porphyry, varying in thickness from 1,600 to 2,000 feet. In the lower part of the bed, the porphyry becomes vesicular, and changes into an amygdaloidal basalt, containing crystals of augite. Basalt, associated with porphyry in enormous masses, often covers the primary mountains of the Andes. They are arranged in regular columns, which strike the eye of the traveller like immense castles in the sky. Porphyritic rocks may, in general, be regarded as more ancient than basaltic rocks, as porphyry most frequently occurs intermixed with, or covering, transition rocks, and basalt is most commonly associated with the secondary strata, which it either cuts through in the form of dikes, or covers unconformably. Sometimes it appears to have broken the strata confusedly, and to have enveloped large portions of other rocks. All the trappean rocks give decisive indications of an igneous origin, not only in the shapes of their masses, but in their action on the adjacent rocks. Where basalt is in contact with gneiss, it becomes nearly compact, and approaches to the character of hornstone; and where greenstone rests on sandstone or clay, these rocks have a red and

burnt appearance, and a hardness superior to what they possess in other places. Where they cross the coal strata, and come in contact with the seams of coal, the substance of the coal is, for several feet, converted into soot. At a greater distance from the trap, the coal is reduced to a coke or cinder, which burns without smoke, and with a clear and durable heat. At the distance of fifty feet from the dike, the coal is found in its natural, unaltered state. The thickness of trap dikes varies from a few inches to twenty or thirty yards. The extent to which they reach across a country has seldom been explored beyond the mining districts. The longest in England extends from the western side of Durham to Berwick, in Yorkshire. These dikes are generally harder than the rocks they intersect, and, when the latter are partly decomposed, often remain, forming vast walls of stone that rise above the surface of the ground. They also extend into the sea, and give rise to reefs of rocks; and, when they cross the beds of rivers, they form fords, and sometimes hold up the water and occasion cascades, of which there are frequent instances on the river Tees. From these circumstances, it seems conclusive that basalt and greenstone (and the same may be affirmed of the other varieties of trap-rocks) were thrown out in a melted state, like lava, and poured over the surface of the ground. The frequent occurrence of trap-rocks forming isolated caps on distant mountains, was for a long time considered as opposing the hypothesis of the igneous origin of basaltic rocks; but a more attentive observation of such districts has established the fact, that these isolated caps are parts of continuous beds, which have, in remote ages, been excavated by valleys, in the same manner as the beds of other rocks, which frequently form isolated caps on detached mountains.

The occurrence of thick beds of basalt, divided into regular pentagonal or hexagonal columns, and disposed in ranges of vast extent and height, early attracted the attention of mankind, and gave rise to various theories respecting their formation. Few countries in the world present more magnificent deposits of columnar basalt than the north part of Ireland and some of the Hebrides. The Giant's causeway, in the county of Antrim, constitutes a small part of a range of this description. The promontories of Fairhead and Borge, in the same range, are situated eight miles from each other. These capes consist of various ranges of pillars and horizontal strata, which rise from the sea to the height of 500 feet. From their abruptness they are conspicuous, and form a pile of natural architecture, in which the regularity and symmetry of art appear to be united with the wild grandeur and magnificence of nature. Many of the columns in the ranges at Fairhead are 150 feet in height and five feet in breadth. At the base along the shore is a wild waste of rocky fragments which have fallen from the cliffs, resembling the ruins of enormous castles. At the Giant's causeway, the columns rarely exceed one foot in breadth and thirty in height. They are sharply defined, and the columns are divided into smaller blocks, or prisms, of one foot or more in length, which fit neatly into each other, like a ball and socket. The basalt is close-grained, excepting the upper joint of the column, which is often cellular. The columns usually have five or six sides; but some have seven or eight, and others only three. Beds of basalt that are not columnar, in some places lie over and also under the columns. The basalt of the beds is amygdaloidal. The columns at Fairhead are not articulated like those of the Giant's causeway; but blocks, which are of great length, lie flat on each other.

TRAVELLER'S JOY. See CLEMATIS.

TREACLE. See MOLASSES.

TREACLE-MUSTARD,—botanically *Clypeola*. A genus of handsome, hardy, annual plants, of the cruciferous order. The violet-thlaspi species, *Clypeola ion-thlaspi*, was introduced to Britain from the south of Europe, in the early part of the 18th century. It has commonly a height of only 3 or 4 inches; its branches rise from every side of the root, and are slender and leafy, and generally lie prostrate on the ground; its leaves are small, narrow at the base, and obtuse and broader at the end; its flowers grow in short close spikes at the extremity of the branches, and are small, yellow, and cruciform, and bloom from May till July; and its silicles are compressed, orbicular, buckler-like, one-celled, and one-seeded. —The wool-bearing species, *Clypeola eriophora*, is white-flowered and about the same height as the preceding; and was introduced about 30 years ago from Spain.—The name treacle-mustard is sometimes given also to some species of erysimums and alyssums.

TREAD. A bruise of the coronet of the hind foot of a horse, inflicted by a blow either from the foot of another horse behind him, or from the calkin of his own other hind foot. It is sometimes so slight as to be easily cured by first carefully cleaning it, and next applying a pledget of tow dipped in Friar's balsam or in tincture of myrrh; but in other instances it is so severe as to involve considerable inflammation and to require poulticing for a few days, followed by the use of Friar's balsam, digestive ointment, or a solution of alum or of white vitriol. In no case must it be neglected; for if not promptly and duly attended to, it may give rise to quittor. See the articles QUITTOR and OVER-REACH.

TREADING. The compressing of sown seed into the soil with the feet of man or of some of the domesticated animals. It serves the same purpose as rolling; and is thought, in some respects, to serve it much better, at least when only common cylindrical rollers are used. "In Flanders, where the minutiæ of agriculture are so much attended to," says Sir John Sinclair,

"it is not unusual to tread fields of a moderate size by the human feet; but this plan cannot be carried to any great extent. The superior sample obtained from the dibble, compared to the drill, is by some attributed to the additional solidity the land receives from the treading of the children employed in the operation. In some districts of England, it is usual either to fold the sheep on the ground sown with wheat, between the sowing and the coming up of the crop, or to drive the flock repeatedly over it at that juncture, in order to give firmness to the soil and greater stability to the crop. By this means, wheat may be raised on land which is naturally too loose in its texture for the profitable production of wheat. Some farmers, on light soils, prefer pigs for that purpose, as better calculated for the process than any other animal, from their great weight, compared to the size of their feet. But in West Sussex, the lighter soils, in dry seasons, are trod by the plough-horses, when turning the seed-furrow. Three plough-horses, instead of going at length, draw the last-made plough-furrow abreast, and thereby tread or compress the line of soil they are turning. The advantages of treading, as more effectual than even rolling, in destroying the larvæ of insects, and preventing the harbouring of vermin in the soil, cannot be questioned. It may likewise contribute to check the vegetation of weeds: it prevents evaporation;—and it is found, that the crops on land thus trod, are not liable to be rusted. It is certainly more applicable to dry light soils; but even in wet ones, when it is impossible to roll the land after it is sown, owing to the wetness of the season, it may be trod afterwards by sheep."

TREE. Almost all subjects of any value or interest respecting trees are discussed in our articles Timber, Alburnum, Duramen, Bark, Ascent of Sap, Lignin, Coppice, Plantation, Forest, Planting, Germination, Growth, Decay, Age of Plants, Wood, Transplanting, Pruning, Barking, Felling, and Landscape-Gardening, and in the articles on the several kinds of trees, both indigenous and exotic; and nothing is left to be done in this place except to note a few general facts respecting the size, growth, maturity, and indigenousness of trees.

On ordinary soil and in ordinary circumstances, the average height and diameter of the spruce fir, at the period of full growth or of full fitness for felling, is from 26 to 100 feet and 47·1 inches; of the larch, from 26 to 100 feet and 30·3 inches; of the pine, from 16 to 65 feet and 34·1 inches; of the poplar, from 19 to 65 feet and 31·8 inches; of the plane, from 16 to 48 feet and 36·1 inches; of the oak and the elm, from 16 to 48 feet and 31·4 inches; of the birch, from 16 to 48 feet and 29·4 inches; of the beech, from 16 to 48 feet and 28·2 inches; of the lime, from 16 to 48 feet and 25·9 inches; of the ash, from 16 to 48 feet and 23·5 inches; of the willow, from 16 to 48 feet and 11·7 inches; of the chestnut, from 13 to 48 feet and 36·1 inches; of the maple, from 10 to 48 feet and 28·2 inches; of the service, from 13 to 39 feet and 17·6 inches; of the acacia-tree, from 13 to 26 feet and 19·2 inches; of the hornbeam, from 10 to 23 feet and 21·2 inches; of the mulberry, from 10 to 23 feet and 16·5 inches; of the wild pear, from 10 to 23 feet and 14·1 inches; of the crab, from 6 to 20 feet and 12·9 inches; and of the walnut, from 6 to 16 feet and 36·1 inches. All trees, however, are greatly controlled in their size by soil, position, exposure, elevation, and climate; and some individuals of almost every species, as compared with all ordinary individuals of the same species, acquire very large dimensions.

Young trees, in all favourable circumstances, manifestly grow with great rapidity; while all old ones appear to common observers to be quite stationary, or, like adult animals, to have entirely ceased to grow; and yet trees of every age, on till the actual commencement of decay, maintain a comparatively steady progress of growth, and acquire seasonal or yearly increments to their bulk. Dicotyledonous trees, in particular, comprising all the kinds which thrive in the open air in Great Britain, make, all their life long, periodical additions to their substance in the form of concentric or superimposed layers of woody tissue; and not a few of them, variously influenced by the intrinsic powers of their constitution and by the extrinsic ones of their situation, make these additions much more bulkily when they are at a somewhat advanced age than when they are young. "With a view to ascertain the amount of increase in the woody layers at different periods, De Candolle measured their thickness, and found that if the annual increase presented a certain regularity, it was still very far from being absolute even in the case of a single species. The oak especially offered striking anomalies; thus a trunk which had grown slowly in diameter was found to have increased more rapidly as it got older. He found young trees of the same species, the growth of which, very slow at first, by and bye became accelerated, and then fell off in a third period of their existence. From the whole of his observations, De Candolle concludes that the growth of our common European trees, having gone on with a certain rapidity to the age of from about 50 to 70 years, then became slower, but continued regular to extreme age. The inequalities of growth, conspicuous in the different thickness of different rings, he thinks are mainly due to the kind of soil which the mass of the roots encountered in their progress, or the removal of other trees which grew in the vicinity. The diminished thickness of the rings after trees have passed a certain age, he ascribes to the depth to which the roots have now penetrated, and their consequent remoteness from the air; and farther, to the resistance opposed

to the expansion of the trunk by the bark, which has now become thick, hard, and unyielding. Mr. Knight found that old pear-trees, relieved of their outer bark, formed more wood in a couple of summers afterwards, than they had made in the 20 years that preceded the operation." "However essential to a tree," says Mr. Dovaston, "are all the skyey influences of air, which cannot be kept from it, light is the grand and indispensable agent of vegetation. A tree deprived of this will soon sicken, and so die. I have very repeatedly seen, when a tree has been cut down near the edge of a thick wood, having the boughs all on the light side, the annual rings, instead of being concentric, have gone off round the place of the pith in vast parabolic curves, like the orbit of a comet on a planetary diagram, the layers being exactly equally numerous on both sides, but vastly wider on the side of the light. Two trees of equal organisation, were it possible, and in equal soils, the one incommoded and the other not, would in a very few years tell utterly distant in the scale of growth; though a tree may be too much exposed, and I have occasionally seen even a sycamore show a weather-side to the storm."

The maturity of trees, or the period at which they begin to lose their vigour, or have reached the extreme verge of maximum fitness for felling, does not depend on mere age or bulk, but is largely determined by the aggregate of the circumstances of growth, especially by those of soil, situation, and exposure. Very old living timber always perishes first in those parts which constitute the most interior ligneous layers; so that to suffer any timber-tree to stand till it begins to give slight exterior indications of decay is, in general, to allow it to lose some of the most valuable portions of its wood. Too young a tree has not all the excellence of timber which it would gain if it were permitted to grow to a higher maturity; and too old an one commonly has the timber of its centre lighter and less valuable than that of its circumference; and every tree is in its prime, as to both the quality and the homogeneity of its timber just at the moment which immediately precedes the decay of its heart or innermost layer. And though the commencement of this decay is so entirely interior as to be profoundly beyond the reach of observation, yet it soon communicates its influence to the whole tree, and rapidly produces external symptomatic indications of its existence. A tree whose top forms one uniformly rounded mass—particularly if it naturally possess a somewhat straggling and freely-branching habit—is in a weak condition; one which comes prematurely into leaf in spring—particularly if it prematurely suffer discoloration and fall of foliage in autumn—is also in a weak condition; one which begins to shrink or die at the extremities of any of its principal shoots or branches has begun to decay in the innermost woody layers of its trunk; one whose bark is here and there cracked or fissured or fallen-off, has undergone a considerable degree of decay in the innermost parts of its trunk; one whose bark is marked with red or black spots, or infested with mosses, lichens, and fungi, is in a suspicious condition, and may possibly be somewhat far-gone in heart-decay; and one whose sap may be observed to ooze through crevices of the bark, is thoroughly diseased, and may already be half-dead.

The upland regions of Britain, and most of all the mountain fastnesses of the Scottish Highlands, afford the best evidence as to the species of trees which are truly indigenous in our country, and which may be grown in it with the highest degree of advantage. The original and natural vegetation of nearly all parts of the globe, excepting such as are covered by shifting soil or perennial snows, consists chiefly of trees and shrubs, differing according to the climate. If, after the revolutions and catastrophes which geology so clearly indicates, the surfaces consisted partly of bare rock, and partly of debris, gravel, sand, and clay, whatever may have been the first vegetation by which these surfaces were covered, it is at least apparent that trees were abundant upon them at a period antecedent to the formation of peat and other soils of vegetable origin; for the decayed stumps and roots of the oldest trees which we meet with may generally be traced to the subsoil, and in few cases occur in soil that is evidently of posterior origin. A considerable portion of Scotland can hardly be supposed to have been covered with trees for many ages back; for in the soil and subsoil the operations of the agriculturist disclose no roots, which, had they once existed, could scarcely have been so entirely decomposed as to leave no traces behind. But the sides of all the Highland mountains, the glens and ravines, the margins of the rivers and lakes, and very extensive tracts of the low grounds, have at some period been covered by wood. Beyond the mere fact, however, that, at a former period, Scotland exhibited extensive ranges of uninhabited forest, where corn-fields and pastures now surround the habitations of a crowded population, little respecting the species is to be learned from the pages of our historians. They can only tell us at random of 'noble forests of oak, ash, beech, and other hard timber;' and in order to discover the real species, we must have recourse to our peat bogs, and to the remnants of the ancient woods which still grace many parts of the country. Yet from the former of even these sources, little information is to be obtained. When trunks, branches, or roots are found in peat, they are generally so altered that the species to which they belong can in only few cases be discovered. The pine, the birch, the alder, and the oak, are all that can be made out with certainty, to which may be added the hazel, upon the occasional evidence of its nuts. In an insular situation like ours,

it is evident, that, unless new species spring up spontaneously, no addition can by natural means be made to the original stock. Shrubs or young trees wafted from the European or American continents, would necessarily perish before arriving upon our coasts; and the seeds of none of our present species of trees are fitted for long aerial voyages, and could scarcely arrive from the nearest point of Europe, even if whirled thence by a hurricane. As to the dissemination of trees by birds, no seeds of any kind, perhaps, have ever been found entire in the intestines, and the hardest are shattered by the least muscular gizzards. The present indigenous trees of the country are, therefore, very probably the species of which its ancient forests consisted. The principal, both in number of individuals and in economical value, are the Scotch pine, the common oak, the white birch, the dwarf birch, the alder, the aspen, the yew, the common ash, the wych elm, the bird cherry, the wild cherry or gean, the crab, the hawthorn, the blackthorn, the common mountain ash, the bastard mountain ash, the whitebeam, and the holly; and a few of either the rarest as to individuals or the most doubtful as to true indigenousness, are the common elm, the beech, the white poplar, the black poplar, the common elder, the dwarf elder, the wayfaring tree, and the bullace-tree.

TREE-CABBAGE. See CABBAGE.

TREE-MALLOW. See LAVATERA.

TREE-OF-HEAVEN. See AILANTHUS.

TREE-OF-SADNESS. See NYCTANTHES.

TREE-ONION,—botanically *Allium proliferum*. A curious, hardy, bulbous-rooted, white-flowered, perennial, herbaceous plant, of the garlic genus and asphodel family. It has commonly a height of about 3 feet, and blooms from July till October, and is propagated from offsets.

TREFALLOW. Ploughing land the third time before sowing.

TREFOIL,—botanically *Trifolium*. A genus of herbaceous plants, constituting the type of a sub-tribe of the lotus division of the leguminous order. Twelve genera are comprised in this sub-tribe; and the chief of these are trifolium, medicago, lotus, melilotus, and trigonella. The flowers of the true trefoils are crowded in an elongated or globular spike or head; the petals generally remain attached when dry or withered; the stamens amount to nine united and one solitary; and the pods in general are shorter than the calyx, and are either one or few seeded. Sixteen species grow wild in Britain; upwards of an hundred have been introduced from other countries; and about thirty unintroduced exotic species are known. All the species in Britain, exotic as well as indigenous, are hardy; about twenty are agricultural, and many of the others are ornamental; about forty-eight are perennials, two are biennials, and all the rest are annuals; several have a height of from 2 to 5 feet, a few have a height of only 3 or 4 inches, and most have a height of from 6 to 15 inches; a considerable number of both the perennials and the annuals are creeping or procumbent, and all the rest are erect. In one subgenus, consisting principally of annuals, and comprising one indigenous species and about twenty introduced species, the flowers are spiked, the spikes have an oblong form and are ebracteate at the base, and the calyx is villous and is not inflated after blooming; in a second subgenus, consisting partly of biennials, much more of perennials, and still more of annuals, and comprising seven indigenous species, and somewhat upwards of forty introduced species, the flowers are capitate, the heads are ovate and often bracteate, and the calyx is villous and not inflated; in a third subgenus, consisting partly of perennials and partly of annuals, and comprising three indigens and about sixteen introduced species, the flowers are capitate and often deflexed, the heads are globose, and the calyx is not inflated; in a fourth subgenus, consisting partly of perennials and partly of annuals, and comprising two indigens and six or seven introduced species, the flowers are densely capitate, and the upper lip of the calyx after the period of blooming rises up in an inflated and arched manner and covers the legume; in a fifth subgenus, consisting principally of perennials, and comprising at least nine introduced species, the flowers are large, the petals are coriaceous and persistent, and the segments of the calyx are subulate or erect; and in a sixth subgenus, consisting principally of annuals, and comprising three indigens and about ten introduced species, the flowers are capitate, the heads are pedunculated and ovate, and the petals are scarious, yellow, deflexed, and persistent. The principal agricultural species are fully noticed in the article CLOVER; the species of the fifth subgenus are briefly noticed in the article LUPINASTER; and the subject of the trifoliate plant which forms the national emblem of Ireland is discussed in the article SHAMROCK.

The indigenous species of the first subgenus is the field hare's-foot, *T. arvense*, an erect weedy annual of sandy fields, about a foot high, carrying flesh-coloured flowers in July and August. The seven indigens of the second subgenus are the striated trefoil, *T. striatum*, an erect weedy annual of barren grounds, about 5 or 6 inches high, carrying purple flowers in June; the rough trefoil, *T. scabrum*, a creeping handsome annual of sandy fields, about 5 or 6 inches high, carrying white flowers in May and June; the starry trefoil, *T. stellatum*, a creeping handsome annual of the southern coasts of England, about 6 or 8 inches high, carrying purple flowers in July; the sea trefoil, *T. maritimum*, an erect handsome annual of salt marshes, about 6 inches high, carrying pale purple flowers in

June and July; and the yellowish-white clover, *T. ochroleucum*, the cow-grass clover, *T. medium*, and the common red clover, *T. pratense*, described in the article Clover. The three indigens of the third subgenus are the suffocated trefoil, *T. suffocatum*, a trailing weedy annual of the seashores of England, about 6 inches in height, carrying white flowers in June and July; the cluster-headed trefoil, *T. glomeratum*, a trailing weedy annual of the pastures of England, about 6 inches in height, carrying pink flowers in June; and the common white clover, *T. repens*, described in the article Clover. The two indigens of the fourth subgenus are the strawberry-bearing trefoil, *T. fragiferum*, a creeping and somewhat agricultural perennial of moist pastures in England, about 3 or 4 inches high, carrying flesh-coloured flowers in July and August; and the subterraneous trefoil, *T. subterraneum*, an erect handsome annual of the barren heaths of England, about 6 inches high, carrying white flowers in May. And the three indigens of the sixth subgenus are the procumbent hop trefoil, *T. procumbens*, the lesser yellow trefoil, *T. minus*, and the thread-shaped trefoil, *T. filiforme*, all described in the article Clover.

TREFOIL (Bird's-Foot). See Bird's-Foot Trefoil.

TREFOIL (Marsh). See Buckbean.

TREFOIL-SHRUB. See Ptelea.

TREFOIL-TREE. See Cytisus.

TRELLIS. A contrivance of the nature of a lattice for supporting the branches of fruit-trees, or for training and supporting the stem and ramifications of ornamental climbing plants. The old-fashioned trellis for fruit-trees, or common wall-fruit trellis, is constructed upon a piered wall, and extends from the inside of one pier to the nearest inside of the next, and is closely similar in at once form, uses, and management to an espalier, and may be diversified, in its aggregate size and outline, and in the materials, dimensions, and arrangement of its rails, to suit the wants of different kinds of trees. See the article Espalier. The ornamental trellis of the flower-garden, particularly in its newest forms and applications, is endlessly diversified in shape and size, and admits of a considerable choice of material, and may be worked into great complexity of compound form, and affords a very wide scope for the combined exercise and display of ingenuity, fancy, caprice, and both good and bad taste. Some kinds of it are mimic and belong only to the greenhouse, while others are gigantic and belong to the open ground; and some are chaste and elegant, and serve only to exhibit the plants upon them to the best advantage, while others are stalking and fantastic, and fix enlightened attention only on their own absurdity. Ornamental trellises, on the whole, give gardens an excessively artificial or downright harlequin appearance; and would have formed a far fitter accompaniment to the clipping and figuring horticulture of a former period than to the natural and flowing style of the present day. "The more we look on the present unnatural-looking shields for our climbing plants, the greater appears the necessity of an alteration. Whatever is unnatural in plant-growing, must have some great advantage to enable us to tolerate it at all. This may be said against plants growing in pots instead of the ground, for nothing but the necessity of doing so justifies it. Plants must be moved about, and therefore something to grow in is necessary, and that something is a pot or tub, or some receptacle for the soil they require. But in all cases, the nearer we can approach to familiar objects in our mode of training the better. There can hardly be a better guide than nature in all this. Where do we find climbing plants? Twining up and round pillars, insinuating themselves into all the crevices of a ruin, festooning the Gothic arch and the glassless window, enfolding the aged tree, and clinging to the ancient gateway. All these things can, more or less, be imitated. A pillar, whether broken or perfect, is not only an appropriate, but a handsome design for a climbing plant. An ancient arched window is well adapted for one of the larger kinds of plants; and there is one great advantage in such subjects, if well made they look better for not being entirely covered."

TREMANDREÆ. See Tetratheca.

TRENCH. A long cut in the ground,—either a single spade-cut in the process of spade-tillage, or a mere furrow-cut for the purpose of draining, or a deep and wide ditch for the purpose of military defence.

TRENCHING. Digging up the subsoil in the process of garden tillage or of spade husbandry. It admits of many degrees and variations; and comprises any depth and amount of interference with the subsoil, from the simple stirring of it and bringing up merely an inch or two, to the complete upturning of a considerable stratum of it and bringing up the whole of this to the surface. It serves, in all its varieties, to renovate the soil, to imperviate the subsoil, to deepen the range and scope of roots, to improve the drainage, to increase the interior circulation of air and moisture, and to promote all the digestional chemical processes which prepare the mineral and gaseous food within the soil for absorption by plants; and it must be adapted, in its particular depth and manner, to the character and circumstances of the particular ground on which it is performed, and by no means done everywhere and indiscriminately in the ordinary manner of making the top-spit and the bottom-spit of land simply interchange places,—a manner which is suited chiefly to a very deep homogeneous garden soil which has been long in cultivation. The trenching of all land whose subsoil differs materially from its soil—and especially of

all land whose subsoil is compact, stiff, and almost wholly destitute of humus—requires to be done with judgment and caution; and yet, when thus done, is proportionally more beneficial than even the complete, mechanical turning upside down of very deep loamy mould. "Let us take the worst possible state of ground for the trenching operation,—bad, poor, sour land which, in its present state, will grow nothing well. A little of it might be brought to the top every time the earth is dug, because exposing even bad soil to the atmosphere will improve it; and if good ground reached only ten or a dozen inches down, this, when we begin to dig, must be removed one trench wide for the first operation, for the purpose of filling in the last left trench. This being removed for a start, in ordinary digging, the next spit dug all along would fill it up, and the ground would be merely turned over; but before we go at the second spit, it would be wise to dig up the bottom and leave it there; for next to bringing it to the top, loosening it at the bottom is best; but taking out about two inches, to put on the top of the good soil, will be found an excellent mode of improving the ground permanently. Then dig the second spit along the space to be trenched, and throw it into the trench; loosen the bottom again, and throw two inches of the stuff on the top of the good soil; continue this all through, one trench after another, until it is all finished, and the result will be, that this small quantity of worthless stuff will become, by the dressing and the exposure, workable and useful. In time two more inches might be brought up, and when it has become well mixed and amalgamated with the better soil, and the dung which is from time to time put on it, the soil which has been for years called shallow and unprofitable, will be far better than the owner could anticipate. In gravelly soil, the ground would soon become stony, but excellent produce will come off stony ground; and by picking the largest off from time to time, even the gravel brought up will be anything but unprofitable in the culture. The worse the ground is in its subsoil, the less must be brought up from time to time; but whether clay, gravel, or chalk, attention to these matters will be repaid by a deeper cultivable soil; and by proper dressings according to its nature, additional produce will be obtained." See the article Spade-Husbandry.

TRENCH-PLOUGHING. See Subsoil-Ploughing.

TREPANNING. See Hydatid.

TREVERINA. A splendid, tropical, scarlet-flowered, evergreen, herbaceous plant, of the fig-wort family. It constitutes a genus of itself, and bears the specific name of *coccinea*, or 'the scarlet;' but it is called by some botanists *Cyrilla pulchella*. It was introduced to Britain from Jamaica in 1778; and has long been a favourite with amateur florists. It has a height of about 20 inches, and blooms in September; and it loves a soil of loamy peat, and is propagated by division of the roots.

TRIANDRIA. See Botany.

TRIANTHEMA. A genus of curious, exotic, green-flowered plants, of the purslane tribe. The monogynous species, *T. monogyna*, is a native of both Indies, and was introduced to Britain from Jamaica in 1820. It is an annual, of about a foot in height, and blooms in May and June. Its root is bitter and slightly nauseous, and is used in India in combination with ginger as a cathartic; its branches lie flat on the ground; and its general appearance is similar to that of common purslane. Some other specimens have been introduced to British collections.

TRIAS. A genus of ornamental, tropical, epiphytous plants, of the malaxis division of the orchis family. The name alludes to the triangular form of the open flower. The oblong species, *T. oblonga*, is a very handsome plant, with dingy green and purple flowers, blooming in November; and was introduced to the orchideous collections of Britain a number of years ago from India.

TRIBES. See Classification.

TRIBRACHYA. A curious, tropical, green-flowered epiphyte, of the orchis family. It was introduced to British gardens from Sierra Leone in 1823; it has a height of only three or four inches, and blooms from midsummer till November; and it constitutes a genus of itself, and is specifically called the pendulous. Its generic name signifies 'three-armed,' and alludes to its spikes.

TRIBULUS. See Caltrops.

TRICHÆTA. A hardy perennial grass, of the oat tribe. It constitutes a genus of itself, and is specifically called the ovate; it was introduced to Britain from the South of Europe about 25 years ago; and it blooms from midsummer till August; but it possesses little or no economical interest.

TRICHILIA. A genus of ornamental, exotic, white-flowered, evergreen tall shrubs and small trees, of the bead-tree tribe. Five or six species, varying in height from 15 to 25 feet, and all blooming in June and July, and propagable from cuttings, have been introduced to British collections from the West Indies and Australia; and upwards of a dozen other species are known. The name trichilia is formed from a word signifying 'ternary,' and alludes to the triple cell and triple valve of the capsule. A warm oil, prepared from the fruit of the thorny species, *T. spinosa*, is regarded in India as a valuable application in cases of paralysis and of chronic rheumatism.

TRICHOCENTRUM. A genus of curious, exotic, epiphytous plants of the orchis family. Several species have been introduced to British gardens since 1834; and one of the first-flower-

ing of these is a small and easily cultivated one called *T. iridifolium*.

TRICHOCHLOA. A genus of exotic grasses, of the agrostis tribe. The name signifies 'hair-grass,' and is descriptive. Five perennial species, and an annual one, all hardy, and mostly about a foot high and blooming in June and July, have been introduced to British collections from various parts of North America; and upwards of 20 more are known. All the introduced species are interesting to naturalists; and four are assigned by some botanists to the genus agrostis; but none possess any agricultural value.

TRICHODESMA. A genus of exotic annual plants, of the borage family. The Indian species, *T. indicum*, called by Linnæus *Borago indica*, is a handsome blue-flowered annual, of about a foot in height, blooming from midsummer till late in autumn, and capable of cultivation in the open ground; and it was introduced to Britain from India in 1759.

TRICHODIUM. See Agrostis.

TRICHOLÆNA. A handsome, exotic, perennial grass, of the sugar-cane tribe. It constitutes a genus of itself, and bears the specific name of *micrantha* or 'small-flowered;' but was regarded by Linnæus as a true sugar-cane, and by Sprengel as a panic-grass. It is a native of Teneriffe, and was introduced to Britain in 1825. It has a height of about a foot, and blooms in June and July; and it forms an interesting object in the greenhouse, but does not possess any economical importance.

TRICHOMANES. A genus of ornamental ferns, of the polypody tribe. The short-bristled species, *T. brevisetum*, called by some botanists *Hymenophyllum alatum*, is a very handsome evergreen indigen of the moist rocks of Britain, about 4 inches high, and blooming in May and June. Nearly 50 exotic species are known. The name trichomanes is given also to a beautiful indigenous species of the spleenwort genus. See the article Maiden-Hair.

TRICHONEMA. A genus of ornamental, bulbous-rooted plants, of the iris order. The bulbocodium species, *T. bulbocodium*, is a native of the Channel Islands and of the South of Europe; and was introduced to Britain in 1739; and is so hardy as to be freely cultivable in the open ground. Its bulb is ovate and esculent, and has two membranous coats; its leaves are spreading and 3 or 4 inches long; its flower-stalks are either simple or branched, and commonly about 6 inches high; and its flowers have a reddish or purplish colour, and bloom in March and April. About twenty species have been introduced, principally from the Cape of Good Hope and the South of Europe; and have variously blue, purple, red, pink, rose-coloured, yellow, and greenish-white flowers; and have for the most part a height of about 6 inches; and love a mixed soil of sand and peat and loam; and must be grown either in the greenhouse or in a pit or frame; and are propagated from offsets. All are beautiful; and several are nearly allied to the ixias.

TRICHOSANTHES. See Snake Gourd.

TRICHOSTEMA. A small genus of hardy, ornamental, blue-flowered, North-American, annual plants, of the labiate order. The dichotomous and the linear-leaved species were introduced to Britain about 90 years ago, and have a height of about a foot, and naturally bloom in June and July.

TRICORYNE. A genus of ornamental, Australian, herbaceous plants, of the asphodel tribe. Two evergreen perennials and one biennial, varying in height from 10 to 25 inches, have been introduced to the gardens of Britain; and they love a soil of rich mould, and are propagated by radical division.

TRICUSPIS. A small genus of exotic grasses of the glyceria tribe. The five-cleft species, *Tricuspis quinquefida*, called by Michaux *Poa cærulescens*, is a native of North America, and was introduced about 30 years ago to Britain. It is a perennial, and has commonly a height of about 2 feet, and blooms in June and July; it thrives best in a soil of rich mould; and it possesses some claims to rank as an agricultural plant.

TRIDENTEA. A genus of Cape-of-Good-Hope, curious, small, evergreen undershrubs, of the swallow-wort family. The name alludes to the fancied resemblance of the flowers to a trident. Seven species, all about 6 or 7 inches high, and mostly carrying dark purple or brown purple flowers, but blooming at very different periods, have been introduced to Britain; and they love a soil of sandy loam, and require the heat of the dry stove, and are propagated from cuttings.

TRIENTALIS. See Winter Green.

TRIFOLIUM. See Trefoil and Clover.

TRIGLOCHIN. See Arrow-Grass.

TRIGONELLA. See Fenugreek.

TRIGONIA. A small genus of ornamental, tropical, evergreen shrubs, of the hippocratea tribe. The name alludes to the three-corneredness of the fruit. Two species, the villous and the soft, have been introduced to British collections from Cayenne and Brazil.

TRIGONIDIUM. A genus of beautiful, tropical, epiphytous plants, of the orchis family. The blunt-petaled species, *T. obtusum*, was introduced to Britain in 1834 from Demerara, and is about a foot high, and carries white and red flowers in autumn; and Egerton's species, *T. Egertonianum*, was introduced in 1837 from Honduras, and is about 20 inches high, and carries yellow and brown flowers throughout a great part of the year.

TRILLIUM. A genus of ornamental, hardy, perennial, tuberous-rooted, herbaceous plants, of the melanthium family. Fifteen species have been introduced to Britain from Canada and the United States of America. Most grow wild in

the American woods, and thrive only in shaded situations, and have a height of from 5 to 10 inches, and carry either red, brown, white, green, or pale purple flowers; and all love a soil of sandy peat, and may be propagated by division of the root. One of the earliest introduced is described as follows by Miller; and may be taken as a fair specimen of the whole. "The root is tuberous, and sends out many fibres. The stalk is single, naked, and rises 5 or 6 inches high, with three oval leaves placed at the top on short footstalks, which spread out in a triangle, and are 2 inches long and 1½ inch broad, smooth, and of a deep green colour. From the centre of the footstalks of the three leaves comes out one flower on a short footstalk, which nods downward. This has a three-leaved green empalement which spreads open; and within are three petals about the size of the empalement, of a whitish green on their outside, and purple within, having 6 stamina in the centre, surrounding the style, which have oblong summits. The flowers appear in April, and are succeeded by roundish succulent berries, having 3 cells filled with roundish seeds, which ripen in June." The ternate exfoliations, particularly those of the calyx, are alluded to in the name trillium. The two-coloured species, *T. discolor*, a green-flowered plant of about 9 inches in height, introduced in 1831 from Georgia, is fragrant.

TRINIA. A small genus of hardy biennial plants, of the umbelliferous order. It is nearly allied to the burnet-saxifrage genus. Hoffman's species, *T. Hoffmanni*, called by some botanists *Pimpinella dioica*, is a weed of rocky places in some parts of England; and has a height of about 10 inches, and carries white flowers in May and June.

TRIODIA. A genus of grasses of the oat tribe. The decumbent species, or heath-grass, *T. decumbens*, called by Linnæus *Poa decumbens*, is a perennial indigen of the spongy bogs and barren heathy mountains of Britain. Its root is very slightly creeping, and has strong fibres; its stem is hard, harsh, rigid, jointed, bent, leafy, and from 4 to 15 inches long, and lies close to the ground, except during the period of bloom; its leaves are linear, striated, rigid, somewhat glaucous, smooth throughout the body, and very rough in the rib and edges toward the point; and the inflorescence is panicled, and blooms in July and August. Eight or nine exotic species are known.

TRIOPTERIS. A genus of ornamental tropical plants, of the Barbadoes cherry tribe. Two species, the silky and the Jamaica, both evergreen climbers of between 5 and 12 feet in height, loving a soil of peaty loam, and propagable from cuttings, have been introduced to the hothouse collections of Britain; and 6 or 7 more are known. The name triopteris signifies 'three winged,' and alludes to the capsule.

TRIOSTEUM. See Feverwort.

TRIPHÆNA,—popularly *Yellow Underwing*. A genus of destructive insects, of the moth tribe. Their caterpillars are subterranean, and therefore root-eaters; and can in general be attacked by the cultivator only by the methods which are used against grubs. The great yellow underwing, or bride's-maid moth, *Triphæna pronuba*, is very common, and does a great deal of mischief both in the garden and in the field. "The expansion of the wings is upwards of two inches. The upper pair are brownish-grey, dark-liver coloured, or some shade intermediate between these two, each with two kidney-shaped marks towards the centre. The under wings are orange-yellow, with a narrow black band at the hinder extremity, but not reaching the margin, and continued along the anterior margin, emitting a narrow streak towards the centre of the wing. The head and thorax are of the same colour as the anterior wings; and the abdomen is like the hinder wings. The eggs are, in all probability, laid in the earth; at all events the caterpillars penetrate into the soil, and pass the greater part of their lives beneath the surface. Their skin is tough and resisting, to fit them for such a mode of life; the colour brown, or dull-livid, with a slight tinge of green, and two interrupted black lines on the back. They pass the winter under the surface of the ground, and are capable of enduring a great degree of cold. Mr. Curtis states that he has known them to be embedded in a sheet of ice and yet recover. They come to the surface early in spring, and prepare to undergo their metamorphosis to a chrysalis, which takes place in April, the moth appearing early in summer. It flies only for a short distance at a time, and chiefly in the afternoon and evening. During the day it may be found lurking at the sides of stones and among grass; and when an attempt is made to seize it, it seldom takes wing, but endeavours to escape by gliding rapidly away among the herbage. It appears to be plentiful in all parts of the country. The caterpillar seems to be a very general feeder, and destroys the roots of many kinds of useful plants. It has been known to commit extensive injury to the turnip crop by eating away the rootlets, and even penetrating into the bulb."

TRIPHASIA. A Chinese evergreen, fruit-shrub, of the orange-tree family. It constitutes a genus of itself, and bears the specific name of *aurantiola* or 'the little orange;' but is called by Willdenow *Limonium trifoliata*. It was introduced to the greenhouses of Britain in 1798. It has commonly a height of about 2 feet, and carries white flowers in June and July; and it requires a soil of rich mould, and is propagated from cuttings.

TRIPLARIS. A small genus of exotic ligneous plants, of the polygonum tribe. The American species, *T. americana*, is an evergreen timber-tree, of naturally about 40 or 50 feet in height, inhabiting the tropical parts of South America, and introduced to the botanical col-

lections of Britain in 1824. The name triplaris alludes to the triplicate arrangement of the parts of fructification.

TRIPOLY,—botanically *Aster Tripolium*. An ornamental, blue-flowered, perennial-rooted, annual-stemmed, herbaceous indigen of the seashores of Britain. It has a height of about 2 feet, and blooms in August and September.

TRIPSACUM. A small genus of exotic grasses, of the maize tribe. Two hardy perennial species, the single-spiked and the dactylus-like, the former about 2 feet high, the latter about 4 feet high, and both blooming in August, have been introduced to Britain from North America; but, though taking their name of tripsacum from the grinding of their grain into flour, they possess very little interest.

TRIPTILION. A genus of ornamental, exotic, herbaceous plants, of the labiate order. Two very handsome species, the spiny and the cordate-leaved, the former blue-flowered, the latter white-flowered, and both blooming from May till August, and capable of being treated in the manner of common hardy annuals, were introduced to Britain about 25 years ago from Chili. The spiny is very abundant in its native country, and bears there the name of Sempreviva on account of the permanence of its deep azure flowers; and it produces these in corymbs, and may be so managed as to bloom throughout a great part of the year. Its root is fleshy, and somewhat like that of a dahlia in miniature; and its radical leaves spring up in autumn as soon as the flowering stems are cut off.

TRISETUM. A genus of grasses of the oat tribe. Three species grow wild in Britain, nearly twenty have been introduced from other countries, and a good many more are known. All the indigenous species were formerly ranked as true oats, and are described in the article Avena. All the introduced species are hardy, and the majority are annuals, varying in height from 1 foot to 6 feet; but none possess any noticeable economical interest.

TRISTANIA. A genus of ornamental, Australian, evergreen, ligneous plants, of the myrtle family. The name signifies 'to stand by threes,' and alludes to the disposition of the leaves and flowers. Seven or eight shrubby species, varying in height from 6 to 12 feet, and two dendritic species of respectively about 50 and 80 feet in ordinary natural height, have been introduced to the greenhouses and conservatories of Britain; and all love a somewhat peaty soil, and are propagable from cuttings. The two trees have white flowers, and bloom in June and July, and require a loamier soil than the shrubs; and the taller one, *Tristania albicans*, popularly bears among the colonists the name of the turpentine-tree.

TRISTEGIS. A small, curious, hardy, perennial grass of the subbiflorous suborder. It takes its name from the circumstance of having three glumes; it constitutes a genus of itself, with the specific name of *glutinosa* or 'clammy;' and it differs widely in character from all the other subbiflorous genera. It has a height of only 6 or 7 inches, and blooms in June and July.

TRITICUM. See Wheat.

TRITOMA. A genus of ornamental, evergreen, Cape-of-Good-Hope, herbaceous plants, of the day-lily family. Four species, varying in height from 12 to 25 inches, and mostly carrying orange-coloured flowers, and blooming at an advanced period in the year, have been introduced to British gardens; and they love a soil of peaty loam, and require frame-protection, and are propagated by division of the root.

TRITONIA. A genus of ornamental, South-African, bulbous-rooted plants, of the iris family. About 25 species, varying in height from 4 or 5 inches to 2 feet, have been introduced to the greenhouses of Britain. Some bloom in spring, some in summer, and some in autumn; most have yellow or fulvous or rufous or brownish or white or orange coloured flowers; and all love a mixed soil of sand and loam and peat, and are propagated from offsets. The name tritonia is formed from a word signifying 'a weathercock,' and alludes to the stamens.

TRIUMFETTA. A genus of tropical, yellow-flowered plants, of the lime-tree tribe. Three annual species of 2 or 3 feet in height, and upwards of a dozen evergreen ligneous species, principally about 3 feet in height, have been introduced to British collections, chiefly from the two Indies; but they possess little interest.

TRIXIS. A genus of ornamental, exotic plants, of the labiate-flowered division of the composite order. A handsome, annual, Chilian species is noticed in the article Leuceria; a beautiful, small, evergreen, ligneous species, of about a foot in height, carrying white flowers in autumn, *Trixis auriculata*, was introduced to the hothouses of Britain about 22 years ago from Brazil; and 6 or 7 other species are known.

TROCHAR. A surgical instrument, used for piercing the rumen of cattle in order to let the gas escape in hoove. See the article Hoove. The trochar closely resembles the instrument used in human surgery in tapping for dropsy; it consists of a short strong stilett, terminating in three cutting edges which converge to a point, mounted on a handle which admits of being forcibly grasped, and having fitted to it a silver tube which reaches from the point to the handle; and when used, the whole is plunged into the flank, the stilett is then withdrawn, and the tube remains as long as the operator judges necessary, and may be secured in the place by means of tapes attached to rings at its base and tied round the body of the animal. It is an useful instrument on any farm of the mixed husbandry, or wherever hoove is of more than very rare occurrence.

TROCHOCARPA. A small genus of orna-

mental, Australian, evergreen, ligneous plants, of the epacris tribe. The laurel-leaved species, *T. laurina*, is a tree of about 25 feet in height, and carries white flowers from April till August; it was introduced to British collections about 26 years ago; and it loves a soil of sandy peat, and is propagated from cuttings.

TROGOSITA. A genus of beetles of the bostrichidæ family. The mandibles are shorter than the head, and crossed; the ligula is almost square, and is not prolonged between the palpi; and the maxillæ have but a single lobe. The Mauritanian species, or the cadelle, *Trogosita Mauritanicus*, is very extensively known for the depredations of its larvæ upon various kinds of field and forest produce. It is a native of the north of Africa; but has been so profusely propagated thence, partly by natural immigration and partly in attachment to articles of importation, that it now occurs in America, and is very common throughout a great part of Europe. It is about four lines long, blackish above, and light brown beneath, and its elytra are striated. The beetle itself is carnivorous, and makes some amends for the mischief done by its larva by destroying the *Tinea granella*. How or where the female deposits her eggs is not yet known; but the larva has been bred by an experimentalist in a Spanish almond, and was found to live there during 15 months, and the beetle which arose from it afterwards lived during 21 months,—so that the entire period of the creature is believed to be not less than 3 years. The larva, when full grown, is about 8 lines long and 1 line broad; its body is whitish, and comprises 12 segments, distinct enough, and rough with short scattered hairs; its head is hard, scaly, and black, and has two sharp, curved, horny jaws; each of the three thoracic segments has a pair of short scaly legs and a pair of obscure spots; and the anal segment is terminated by two very horny hooks. The larva makes very great havoc among grain locked up in granaries, eating the outside of it, and passing so freely from one seed to another as to injure more than it consumes; and it also attacks dead trees, and even bread and nuts, and is very commonly found beneath the bark of trees; and when it has completed its period, it buries itself in the ground, and there undergoes transformation into a pupa.

TROLLIUS. See Globe Flower.

TROMOTRICHE. A genus of curious, South-African, evergreen undershrubs, of the swallow-wort tribe. Five genera, varying in height from 6 to 25 inches, and carrying dark-coloured flowers, principally purplish, in June and succeeding months, have been introduced to British gardens; and they require the heat of the dry stove, and love a soil of sandy loam, and are propagated from cuttings.

TRONA. The native sesquicarbonate of soda. It occurs on the banks of the alkaline lakes of Sukenah in Africa, and is imported thence to Britain.

TROPÆOLUM. See Indian Cress.

TROPHIS. See Ramoon Tree.

TROT. The medium one of the three natural paces of the horse. See the articles Manege and Pace. It comprises two varieties,—the slow and the swift; yet has been very generally described in terms which exclude the latter. In the slow trot—or what most persons regard as the only trot—the off fore leg and the near hind leg are simultaneously elevated and replaced, while the near fore leg and the off hind leg are on the ground, sustaining the whole weight and making ready for action, and *vice versa*. But in the swift trot, all the four feet, though moving in the same order as in the slow trot, or in diagonal pairs, are kept in such rapid action as to be all simultaneously in the air, each sustaining pair being off the ground before the alternate pair alight. "In the slow trot," remarks Delabere Blaine, "the near fore and off hind legs are preparing for elevation only, while the off fore leg and near hind are yet in action, and these raised legs are, in this instance, first set down before the near fore foot and off hind are actually removed from the ground. But in a fast trot these same feet are completely lifted from the ground, while the off fore and the near hind are yet in full progress. At this moment, it must be clear that the horse is all in air; and it is this complete elevation from the earth which forms the essential difference between the slow and the extended trot. To pursue the description, the animal still acting on the impulse derived from the near fore and off hind, they become carried across the off fore and near hind at the moment these latter meet the ground. The off fore and near hind having met the ground, immediately prepare to rebound from it, and to give a fresh impetus to the motion before the near fore and off hind legs again come down; which then forms the second period when the horse is all in air, or, in other words, is again aërially elevated, and as totally detached from the ground as a bird when flying, or as the horse is understood to be when either leaping or galloping. If it should still not be readily comprehended how the horse should be without support at any time during the trot, let us draw a parallel between the progression of a biped and that of the horse. In the walking of a man, one foot becoming elevated is carried forward, and set down,—during which the body is likewise carried forward, and the centre of gravity takes a new line through the moving mass; the contrary foot is now elevated also in its turn, and repeats all the phenomena of its fellow. In running, so essential a difference may be observed, that let running be conducted ever so slowly, and walking ever so fast, so that the speed shall be greatly in favour of walking, yet the paces will remain totally distinct. In the running of man, as well as in the extended trot of the horse, there is a period when all the supports are completely removed from the

ground; for by means of the flexion and extension of the angles of one of the lower extremities of the man, a spring is made, which displaces and elevates the body, inclining it forwards, and taking the first elevated leg with it, which, before it meets the ground, is crossed by the other. The body, losing its impetus, waits for fresh impulse to be gained by the rebound of the limb which was last elevated, and is by that means again propelled forward; the contrary leg once more passes, to be ready to receive the propelled weight thrown on it, and again, by flexing and extending its angles to relieve itself, it renews the action. Exactly the same happens in the extended trot of the horse as in the running of the man, for here the fore and hind diagonal extremities of the horse, acting in unison, form themselves, as it were, into a single support, as one leg, the centre of motion being placed diagonally across it; by which the superincumbent weight, although moving on two distinct members, yet these members, acting in perfect accordance, produce one effect. The principles of the trot, therefore, are illustrated by the running of a biped, and correspond with it in the mechanism of its action."

TROTTELS. See Comfrey.

TROUGH. An oblong vessel, for holding any kind of liquid; — or, figuratively, any kind of oblong depression, such as the hollow between two waves in a stormy sea, or a hollow surrounded by heights or hills in an undulated country.

TROUT. Several species, and many varieties, of abdominal malacopterygian fish, of the salmon genus.

The great trout of the Lake of Geneva and of some neighbouring lakes, *Salmo lemanus*, sometimes weighs from 40 to 50 pounds. Its flesh is white, and its head and back have a whitish ground-colour, and are sprinkled with small round blackish spots.—The dotted alpine trout, found in the lakes of Lombardy and of all the Alpine Countries, *Salmo punctatus*, is dotted with small black and red points, and has delicious flesh.—The marbled trout of the lakes of Lombardy, *Salmo marmoratus*, is closely and irregularly streaked and spotted with brown somewhat in the manner of some kinds of marble, and possesses a not very remote affinity to the *Salmo salvelinus* or English char.

The salmon trout, *Salmo trutta*, occurs in rivers and rivulets at all moderate heights above sea-level, and far in the interior of countries; but is best in streams of clear water which empty themselves directly into the sea. It is marked with ocellated or X-shaped spots, and has sometimes around the upper ones circles of a lighter colour, and displays many of the spots on the opercula and adipose fin; and its flesh is reddish.

The common trout, *Salmo fario*, occurs in almost every stream, both small and great, whose waters are clear and rapid; and is generally smaller than the salmon trout, and often so small as to weigh only 5 or 6 ounces, but comprises some varieties of ordinarily about 4 pounds in weight, and is, in some instances, so large as to weigh even 30 pounds or upwards; its hues and markings vary infinitely in both tint and character, but, in the most abundant instances, comprise ash-colour on the back, some ground-colour on the sides between white or golden yellow and a deep brown, and spots or sprinklings of brown on the back,—and of red on the flanks, surrounded by a lighter-tinted circle; its head is short and roundish, — its nose blunt, — its mouth wide and filled with teeth, not only in the jaws, but also on the palate and tongue,—its scales small,—and its tail broad; and its flesh is commonly white,—but, in all the best specimens when dressed, is either yellow or red. The general shape of trouts is rather long than broad; and in several of the Scotch and Irish lakes and rivers, they grow so much thicker than in those of England, that a fish from 18 to 22 inches will often weigh from 3 to 5 pounds. The female fish has a smaller head and deeper body than the male, and is of superior flavour.

In Llyndivi, a lake in South Wales, are trout called coch-y-dail, with red and black spots as big as sixpences; and others unmarked, and of a reddish hue, which sometimes weigh nearly 10 pounds, but are ill-tasted. In Lough Neagh in Ireland, are trout called buddaghs, which rise to 30 pounds, and some are taken in Ulles-Water, in Cumberland, of still greater weight; and both these are supposed to be similar to the large trout of the Lake of Geneva. In many points the trout taken out of the same river, or of the same pool, agree, and in some they vary; but they are supposed to spawn promiscuously, and all are similar in shape, and in the number and disposition of the fins. A very experienced angler records that in several of the northern rivers of England, he has taken trouts as red and as well tasted as any char, and whose bones, when potted, have dissolved like those of the char,—that about Michaelmas he has caught trouts of a copperish hue without spots, whose flesh, when dressed, was like bees'-wax, and well tasted,—that likewise in April he has taken one of these trouts 28 inches long, and thick in proportion, which boiled yellow, but was equally good,—and this he thinks was the bull trout mentioned by Walton and several authors, as extraordinary both for its size and goodness, and to be found nowhere but in Northumberland. Walton mentions the Fordwich trout, taken in the river Stour, of which only one instance was ever known to be caught by the angle. It is said to be delicious eating; and one weighing 26 pounds, and of a most beautiful colour, was taken with a net in December 1797. The gillaroo trout, found in Loughs Corrib and Mask in the west of Ireland, is highly esteemed for its fine flavour, and has the reputation of being more acceptable to gourmands than any other kind of trout. It com-

monly weighs from 12 to 18 pounds, but sometimes rises so high as 30 pounds. It has a similar appearance to the common trout, but is thicker in proportion to the length, and has a redder hue of flesh both before and after being dressed, and possesses the remarkable peculiarity of having a gizzard somewhat similar to that of a large fowl or a turkey,—and this gizzard, when dressed, is a very favourite morsel. Some supposed varieties of trout, in many of the waters of Britain, or rather peculiar salmonic individuals which anglers regard as curious or remarkable trouts, are probably salmon smelts.

In the end of September trouts leave their hot-weather retreats, and go in search of suitable spawning ground; in October in some rivers, but chiefly in November in most rivers, they spawn; in the following months, they are feeble and wasted,—though some barren females may sometimes be found who continue plump and strong during all the winter; and in February in mild open seasons, or in March in more severe years, they begin to leave their winter quarters, and approach the shallows and tails of streams, and there cleanse themselves and seek restoration to health and vigour. As they acquire strength, they advance still higher up the rivers, until they find summer residences, and for these they generally choose eddies, behind a stone, a log, or bank that projects forward into the water, and against which the current drives, —whirlpools and holes into which sharps and shallows fall, under roots of trees, and in places shaded by boughs and bushes. In small rivers, they frequently lie under sedges and weeds, especially in the beginning of the year, before their perfect strength is recovered; but when in their prime, they feed in the swiftest streams, and are often found at the upper end of mill-pools, at locks, flood-gates, and rivers, also under bridges, or between two streams running from under their arches, and likewise in the returns of streams, where the water seems to boil; and in the decline of summer, they lie at mill-tails, or end of other streams, and in the deep water. Trouts may be said to be in season from March to September, but are fattest during the five or six weeks succeeding the middle of August.

TROWEL. A mason's hand implement for applying mortar. A narrow one of 7 inches long in the blade, 5 inches long in the handle, and $1\frac{1}{2}$ inch high in the vertical connexion of the blade with the handle, is serviceable in various operations of the farm and the garden, and will be found indispensable in laying the sole-tiles of some kinds of subsoil drains.

TROXIMON. A small genus of ornamental, hardy, perennial-rooted, herbaceous, North-American plants, of the succory division of the composite order. The glaucous species, *T. glaucum*, was introduced to Britain from Missouri in 1811. It is about a foot high, and carries yellow flowers from June till August; and it comprises two distinct varieties,—the one with spreading and hirsutely tomentose scape and leaflets of the involucre, and the other with these organs erect and perfectly glabrous. Two other yellow-flowered kinds, the cuspidate and the marginate, both about the same height as the glaucous, and regarded by some botanists as varieties of it, and by others as separate species, were introduced several years later from Louisiana. The name troximon signifies "eatable;" and points at the supposed useful qualities of the plants.

TRUFFLE,—botanically *Tuber*. A genus of fungi of the gasteromycetous tribe. The esculent species, *Tuber cibarium*, is one of the most wholesome and nutritive of the eatable fungi; it grows under ground, and has neither roots nor leafy appendages, but consists of globular vesicles, and absorbs nutriment at every point of its surface; it abounds in some situations in a wild state, and is also raised artificially in beds so formed as to contain suitable niduses for its spores; it is discovered in its natural habitats by means of dogs, who are taught to scent it, and who, on finding it, bark and scratch it up: and it is served up as a rare luxury at the tables of the wealthy, either roasted in a fresh state somewhat like potatoes, or dried, shred, and dressed as an ingredient in soups and ragouts. The form of it is rugosely tubercular, more or less approaching the form of a sphere, or of an egg, or of a kidney, with a somewhat warty roughness. The colour of the surface, in the young state, is whitish, but, in the full-grown state, either blackish or a deep black. The colour of the inside is whitish, with dark blue and white, grey, reddish, light brown, or dark brown veins, of the thickness of a horse-hair, which are usually variously entangled, and which form a kind of network or mat. Between the veins are numerous cavities filled with a great deal of mucilage and small solid grains; and these scarcely visible glands were formerly said to be the seeds or germs of the young truffles. The less the inside of the truffle is coloured by dark veins, the more tender and delicious is its flesh. The blackish external rind is hard, and very rough, by means of fine fissures, grains, and protuberances; and forms with its small facets, which are almost hexagonal, an appearance by which it somewhat resembles the fir apples of the larch. Whilst the truffle is young, its smell resembles that of putrid plants, or of moist vegetable earth. When it first approaches the period of full growth, it diffuses an agreeable smell which is peculiar to it, resembling that of musk, but which lasts only a few days; this smell then becomes stronger, and the nearer the fungus is to its death and its dissolution, which speedily ensues, so much the more unpleasant and urinous is the smell, till at last it is quite disagreeable and putrid. Whilst young, the flesh is watery, and insipid; but when fully formed, it is firm like the kernel of the almond and the nut, and

has an extremely aromatic and delicious taste. As soon, however, as the fungus begins to decay, and worms and putrescence to attack it, its taste is bitter and disagreeable. Wherever truffles are produced, they are to be found from the beginning of spring till late in autumn; but in the greatest plenty from towards the end of August till the end of October. They thrive extremely, like all fungi, in warm moist autumns, and are then most delicious. After warm continuous showers, they are found nearer the surface of the soil, sometimes so high that they form little hemispherical mounds of earth, in which small clefts are produced by the sun's rays. If the soil is loose, and dry weather succeeds, the earth which was raised up falls down, and the truffle is seen half uncovered. Truffles in this state, however, are of small value, as they are generally either dead or worm-eaten. The favourite habitat of truffles is a somewhat moist light wood soil, which is defended from the immediate effect of the burning rays of the sun by large oak trees, standing at a distance from each other, but is not deprived, by thick bushes, of the free access of currents of air. Where, in woods, there are places bare of timber-trees, and with but few bushes, or covered with pollarded wood that does not stand thick, they thrive under an oak, beech, whitethorn, and even under a fruit tree, and sometimes attain the weight of from a pound to a pound and a half. This unusual size, however, is only met with in warm moist grounds. Here they lie nearer the surface of the soil. The drier the soil is, the deeper they are produced in it; but except in the vicinity of springs, they are usually so much the smaller.

Some kinds of truffles differ in the greater or less degree of roughness of the external rind, in a stronger smell, resembling that of garlic, and in a lighter or darker colour. Amongst all truffles, the white is of most value, and in highest request. It grows in Upper Italy, chiefly in Piedmont. Its surface is of a yellowish brown, or pale grey yellow, covered with protuberances resembling warts. The veins in the inside are more delicate than in the black kind, and are of a reddish yellow colour. Between the veins, the flesh of truffles that are fully formed, and their sap vessels and glands, are of a reddish colour. The smell and taste of the white truffle are much superior to those of the black; and on that account, it is more deserving of cultivation. Only the first plantation requires to be circumstantially attended to, as living pieces can seldom be procured; and to plant dead ones in new plantations is useless. Since this white truffle never degenerates to the black, but constantly produces the same, it appears to be not a variety, but a particular species. It is also found in vineyards, meadows, and even in ploughed fields; but the black ones are found only near to forest trees.

The hog-truffle, swine-truffle, or wild truffle, *Tuber suillum*, is generally kidney-shaped, usually reaches the size of a bean, and only under very favourable circumstances that of a small hen's egg. It has a thin leather-like rind, which is covered with many small round warts, without any flat interstices. By means of these, it is distinguished from the kidney-shaped varieties of the esculent truffle. The flesh is juicy, and traversed by coarse veins, which are not very crooked. The smell is disagreeably sour, and is like that of swine's dung, on which account it has received its name. Its taste is unpleasant and insipid. On account of its disagreeable taste and smell, it is not used as food; and none but avaricious truffle-hunters mix it among the edible truffles, along with which it is often found. There are, nevertheless, districts in which none but swine-truffles are to be met with. They are usually found in abundance in such tracts of land as are not mellow, but inclined to sourness. Young plantations of truffles may easily be spoiled, and all labour and expense be useless, if, through inattention or want of knowledge, the swine-truffle is transferred from its old place of growth into the new. As the real truffle prefers the oak, so the swine-truffle seems to prefer the whitethorn; and the real truffle usually occurs singly and in small numbers, while the swine-truffle grows under the whitethorn in groups of from twenty to thirty.

The small truffle, *Tuber minimum*, lives in much society, or always occurs in great numbers together. It attains only the size of a pea, and is of an irregular form, approaching to that of a sphere. Formerly it was thought to be the young progeny of the edible truffle. The stag truffle, *Tuber cervinum*, is the largest kind. It has a globular form and a loose spongy flesh, which, in the midst of its body, has so little coherence, that it forms a dusty core or heart. It is not used by man; but red-deer scrape it. All truffles receive their nourishment by means of absorbing vessels, which cover their whole superficies, in the form, generally, of small warts; and for this reason, they can thrive in none but moist situations, which offer them, in sufficient quantity, matter dissolved in water. In proportion as the earth about them dries up, the fungi must wither away. They have indeed, in their interior, vessels which contain water, to enable them for a time to do without external moisture; but if the drought continues, their internal provision is exhausted, and they become unhealthy, and must at length perish from thirst. Yet too much moisture is also injurious and even destructive to them. Acids are generated, mould and numerous other parasitic plants get a footing upon the surface of the tubes, and by degrees obstruct the absorbing vessels, and cause the truffle to consume or putrify; the mould also allures many small worms, which establish themselves upon the truffle, and live upon its

flesh. Upon the first production of the esculent truffle, its size is scarcely perceptible. As it proceeds in its growth, the earth that is around it is pressed together and pushed off, and on this account the truffle can prosper in none but a loose soil. If the soil is everywhere equally loose, the truffle assumes a globular form; but this is changed, if there is on one side a greater opposition than on the other, as, for instance, by a root or a stone. Where the soil is most moist, whether above or under the truffle, there it will either rise up or sink deeper. The degree of power of attraction of the moisture in the earth, to that in the truffle, necessitates such a change of place. In moist summers and in wet winters, truffles are found near the surface, and even projecting above it, while in dry summers, upon poor dry places in woods, they have often to be dug from a depth of more than half a foot. Here is imposed upon them a greater pressure of superincumbent soil. If the earth is not very light, they cannot be fully developed, and therefore remain small. The largest are, consequently, in general, found not deep under the earth, and in shaded light soil that is somewhat moist. These, however, are not so well tasted as those of middling size; they are also usually injured, and therefore of a bitter taste; for the access of their enemies, worms, snails, and quadrupeds, is much facilitated when no deep stratum of earth protects them against these attacks.

Of all species of trees, an oak standing aloof from other trees with its branches widely extended, collects about it the greatest number of edible truffles. It keeps off the burning rays of the sun, but at the same time permits the free co-operation of the air and of warmth. Under it, truffles acquire the most delicious flavour, and sometimes are so large as to be three or four inches in diameter and to weigh from a pound to a pound and a half. Truffles are also dug up, in woods that are not crowded, under hornbeams, elms, maples, and other deciduous trees; but less plentifully, not so well-flavoured, and less in size. In close pine woods they entirely fail, and are rare in woods of mixed kinds of trees. Hence vegetable mould from oak-leaves and decayed oak appears to contribute to the production and the growth of truffles, as advantageously as the dung of horses and asses does to the production of mushrooms. In the one case, a peculiar animal matter produces the effect, in the other a peculiar vegetable matter,—perhaps the tannin, or some other yet undiscovered product of the oak-tree. The more of this matter any species of tree contains, with the greater facility are truffles produced in its vicinity, and in greater numbers. He, therefore, who wishes to lay out truffle-beds, must endeavour to accumulate this matter in the soil where he intends them to be, and to introduce those circumstances under which the production and thriving of this fungus are promoted.

TRUG. A hod for mortar.

TRUMPET-FLOWER,—botanically *Bignonia*. A genus of ornamental, exotic, corolliflorous, ligneous plants, constituting the type of the natural order Bignoniaceæ. See the article Bignonia. A number of species formerly belonging to it are now assigned to seven other genera; and some of the best known and most magnificent of these are noticed in the articles Catalpa, Tecoma, Spathodea, and Gelsemium. But about 60 species which occur in British gardens still belong to it; and at least 20 more are known. Upwards of a dozen of the introduced species are tropical, erect, evergreen shrubs and small trees; two are respectively hardy and half-hardy deciduous climbing shrubs, from 10 to 30 feet in height; and most of the others are hothouse evergreen climbers, varying in height from 4 to about 50 feet. Upwards of one-third have binate, tendrilled leaves and one or few flowered peduncles,—some carrying their flowers racemosely, and others paniculately; about a dozen have ternate tendrilled leaves; a few have digitate leaves; one has simple, cordate, fine-nerved leaves; and about ten or a dozen have either simply pinnate, bipinnate, or compoundly pinnate leaves. About one-third have flowers of some shade or combination of yellow; and the rest have variously scarlet, orange, pink, purple, white, green, or variegated flowers.

The capriolate or tendrilled trumpet-flower, *Bignonia capriolata*, is a native of North America, and was introduced to Britain in 1710. It is one of the hardy deciduous climbers, and makes a fine show in shrubberies and upon large trellises. It rises by the assistance of tendrils or claspers, and has commonly a height of about 15 feet; its leaves sometimes come out singly, but generally in pairs, oppositely, at the joints, and are oblong, and continue so long in winter as to make the plant really a subevergreen; the flowers come out from the wings of the leaves, and are monopetalous and bell-shaped, and have a very large tube, with an outspread and divided rim, and are large and of a yellow colour, and bloom in June and July, and are succeeded by short pods.

The claw or quadrifoliate trumpet-flower, *Bignonia unguis*, is a native of the West Indies, and was introduced to Britain in 1759. It is the half-hardy deciduous climber; and makes fully as fine a show as the preceding. Its branches are very weak and slender, yet wind about every thing near them, and sometimes rise so high as to overtop trees of from 20 to 30 feet in height, —and they are very tough, and have a smooth surface, and are often of a reddish colour, particularly on the side next the sun; its tendrils grow from the joints, and are curved and tripartite, and have a claw-like form; its leaves grow in pairs at the joints, and are four in number at each, and have an oblong form, an elegantly green colour, and a very ornamental

aggregate appearance; and its flowers come out from the wings of the leaves, and commonly grow two together at each joint, and are similar in shape and size and colour to those of the capreolate species, and bloom in July and August.

Some of the most beautiful or interesting of the other species are the equinoctial and Chamberlayne's, *B. æquinoctialis*, and *B. Chamberlaynii*, two yellow-flowered, binate-leaved, evergreen climbers, from Guiana and Brazil, commonly about 40 feet in height, and blooming from April till October; the lovely, *B. venusta*, an orange-flowered, ternate-leaved, evergreen climber, from tropical South America, commonly about 4 feet in height, and blooming from September till December; the milk-flowered, *B. lactiflora*, a white-flowered, binate-leaved, evergreen climber, from Santa Cruz, commonly about 20 feet in height, and blooming in June and July; the jasmine-like, *B. jasminoides*, a purple-flowered, greenhouse, evergreen climber, from Moreton Bay, commonly about 30 feet in height; and the white-wooded, *B. leucoxylon*, a pink-flowered, digitate-leaved, evergreen erect shrub, from the West Indies, commonly about 12 feet in height, and blooming in June and July. Most of the species thrive best in a soil of loamy peat; two or three, particularly *B. unguis* and *B. crucigera*, are most readily propagated from layers; and all the rest, with only one or two exceptions, are most readily propagated from cuttings.

TRUNDLE. A low, coarse carriage, with small wheels, for carrying heavy and cumbrous loads.

TRUNK. The stem of a tree,—principally the part between the ground and the commencement of the ramification.

TRUSS. A bundle of hay, straw, or other dried forage. A truss of straw weighs 36 lbs., a truss of hay weighs 56 lbs., and 36 trusses make a load; but in June, July, and August, a truss of new hay ought to weigh 60 lbs. See the articles Straw and Hay.

TRUSS OF FLOWERS. Any kind of inflorescence which carries many ornamental blossoms on one peduncle or common footstalk,—and particularly such as has the individual flowers well free from one another, so that each is as distinct an object as the whole.

TUBER. The peculiar subterraneous development of a tuberous-rooted plant. It is popularly regarded as a root, and has been called by some botanists a subterranean stem; but differs widely in structure and functions from both a root and a stem, and comprises a complicated system of contrivances and secretions for achieving propagation, quite independently of the propagational organisms which its plants possess in common with more fibrous-rooted species. Its peculiar structure and uses, as exemplified in potato tubers, are noticed in the article Potato; and its affinities of character and function to a bulb may be learned from the article Bulb. The tuber of some plants is single and quite solid, as in the case of *Bunium bulbocastanum;* the tubers of others are in pairs, comprising an old, exhausted, or light one which has ministered to the present year's growth, and a young, plump, and heavy one which will minister to the growth of next year, as in the case of *Orchis mascula;* and those of other plants generally amount to more than two, and may be pretty numerous according to circumstances of prolificity, and contain large supplies of germs and nourishment whence great annual crops may be raised, as in the cases of the potato, the dahlia, and the Jerusalem artichoke.

TUBER. A genus of fungi. See the article Truffle.

TUBEROSE,—botanically *Polianthes*. A small genus of exotic, ornamental, tuberous-rooted plants, of the day-lily family. The common or tuberous species, *Polianthes tuberosa*, is a native of India, and was introduced to Britain in 1629, and has very long been cultivated in Italy, for the exportation of its tubers to other countries, in the same manner in which tulips, oriental hyacinths, and other bulbous-rooted beauties are cultivated in Holland. It has a flower somewhat like the narcissus, but far more powerfully fragrant, and was called by the old gardeners the tuberous Indian hyacinth. Its stem is commonly about 3 feet high; its flowers are white, and bloom in August and September; its corolla is monopetalous and funnel-shaped, with an oblong incurved tube and an outspread six-segmented brim; and its fruit is an obtuse, roundish, three-cornered, three-celled capsule, full of plain half-round seeds disposed in a double range. One variety has a weaker and shorter stem, and a smaller flower, than the normal plant; another has striped leaves; and another—now the universal favourite of cultivators, and often spoken of as if it were the only tuberose—has double flowers. Yet this last variety, though at present so common, originated not much upwards of a century ago in a garden in Holland, and was for many years prevented by the proprietor from passing beyond the limits of his own grounds, in order that he might have the silly boast of being the only owner of this flower in Europe. The tubers may be purchased from seedsmen in the same way as "Dutch roots;" and they should be potted in sandy loam, and brought forward in a frame with a little bottom heat; and when the plants are coming into flower, they may be removed to the greenhouse or the sitting-room, provided their powerful fragrance should not be felt inconvenient in the latter. The cultivation is very easy; but the tubers do not succeed in the second year, unless the plants are repotted in heat, and kept close to the glass till the leaves decay. Tuberoses are planted in the public gardens of Paris at distances of 50 or 60 yards from one another; and they diffuse a delightful odour in the mornings and evenings when the dew is on, or after a shower of rain.—The slender tu-

berose, *Polianthes gracilis*, was introduced to Britain in 1822 from Brazil. It has pale yellow flowers, and a similar height and time of blooming to the common tuberose; and is also propagated from offsets, and loves the same kind of soil; but requires a considerably greater degree of heat.

TUBEROUS ROOTS. See TUBER and POTATO.

TULBAGHIA. A genus of ornamental, bulbous-rooted, herbaceous, South-African plants, of the day-lily family. Three brown-flowered species, of from 6 to 15 inches in height,—the onion-scented, the garlic-scented, and the allied,—were introduced to Britain between 1773 and 1821; and another and much more beautiful species, the violet-flowered, was introduced at a considerably later period. The leaves of this last are several, sheathing at the base, linear-sword-shaped, 6 or 8 inches long, ¼ of an inch broad, obtuse, quadrifarious, glabrous, coriaceous, rigid, and bright green; the footstalk is erect, slender, filiform, glabrous, and a foot or more high; the inflorescence is an umbel, whose flowers amount to 8 or 9 and open in succession; and the flowers are erect, patent, purple, bright, and shining, and emit a powerful alliaceous fragrance. The three brown-flowered species bloom in spring or the early part of summer; the violet-flowered species blooms in October; and all love a soil of rich mould, and are propagated from offsets.

TULIP,—botanically *Tulipa*. A genus of ornamental, bulbous-rooted, monocotyledonous, herbaceous plants, constituting the type of the natural order Tulipaceæ. This order will probably be so revised by future botanists as to comprise many of the numerous genera which have hitherto been included in the asphodel group, the day-lily group, the amaryllis group, and some cognate families,—and will then be the most superb for floral glory within the whole range of vegetable existence; and even in its present very restricted condition, though comprising but eight or nine genera, it presents to view a vast and dazzling collection of combined beauty and brilliance, and contributes to the parterre a large proportion of its most gorgeous ornaments, and claims, in the estimation of the ablest critics, to comprise the chief objects of allusion in the saying of Infinite Wisdom,—"Consider the lilies of the field, how they grow; they toil not, neither do they spin; and yet I say unto you that Solomon in all his glory was not arrayed like one of these." The principal tulipaceous genera are lilium, tulipa, fritillaria, yucca, erythronium, and gloriosa; and these strike all eyes, from the child to the philosopher, as magnificently beautiful. Only about 120 species, irrespective of varieties, occur in British gardens,—and of these 3 or 4 require hothouse culture, 12 or 14 are suited to the greenhouse, and all the rest thrive well in the open ground.

The tulip genus comprises one indigenous species, about twenty-five introduced exotic species, and an innumerable multitude of varieties. The roots of all its plants are bulbous; the leaves are few and grow from the root-crown, or from the basal part of the flower-stem; the flowers are chiefly solitary, and sit on long, naked footstalks; the perianth consists of six fleshy, coloured, large sepals; the stamens are six in number, subulate, and shorter than the sepals, and terminate in oblong four-cornered summits; the stigma is three-lobed, triangular, sessile, and persistent; and the fruit is a triangular three-celled capsule, full of smooth compressed seeds. The name tulip is corrupted from a Persian word which both designates the garden tulip and signifies a turban. One or two of the species require a little frame protection; and all the others are perfectly hardy.

The wild or indigenous tulip, *T. sylvestris*, occurs on calcareous grounds, and especially in chalk pits, in Middlesex, Hertfordshire, Suffolk, and Norfolk; and has also been found in Scotland; and is more or less plentiful in many parts of France, Switzerland, Italy, and Southern Germany. It naturally propagates itself by sending out a long strong fibre from its root, and developing at the end of this a new bulb; so that the offspring arises at a considerable distance from the parent. The stem is about a foot high, one-flowered, and somewhat drooping; the flower is sweet-scented, and has a bright yellow colour, and blooms in April and May; the sepals of the perianth have an ovate-acuminate form, and are hairy at the extremity; and the stamens are hairy at the base.

The small yellow or Cels's tulip, *T. Celsiana*, is a native of the Levant, of Southern Europe, and of the basin of the Wolga. It was known to Clusius, Tournefort, and some other early European botanists as a distinct species; but was confounded by Linnæus with the wild tulip, though differing greatly from it in size; and was restored to the rank of a separate species by Redouté, the author of the huge French work *Les Liliacées*. Its leaves are lanceolate; its stem is one-flowered, and commonly about 18 inches high; its flower is mostly erect, and has a greenish yellow colour, and blooms in June and July; its sepals are lanceolate; and its stamens are slightly hairy above the base.

Clusius's tulip, or the white and red Italian tulip, *T. Clusiana*, is a native of Sicily, Italy, and the South of France; and was introduced to Britain from the first of these countries in 1636. It was confounded by Linnæus with the common garden tulip; and, like Cels's, was restored to the rank of a separate species by Redouté. Its size is similar to that of the wild tulip; its leaves are linear-lanceolate; its stem is smooth, one-flowered, and about a foot high; its flower has a white and red or white and purple colour, and blooms in June; and its sepals are acute.

The two-flowered yellow tulip, *T. biflora*, is a native of the salt deserts in the basin of the

Wolga, and often occurs in company with the small yellow tulip, and was introduced to Britain in 1806. Its leaves are lanceolate and spreading; its stem is two-flowered or three-flowered, and commonly about 6 inches high; and its flowers are yellow and fragrant, and bloom in April.

The sun's-eye or Agen tulip, *T. oculus solis*, is a native of Italy, France, Germany, and other parts of Europe; and was introduced to Britain from the first of these countries in 1816. It was unknown to Linnæus; and was first described by St. Amans, who found it at Agen in France. Its leaves are oblong-lanceolate; its stem is one-flowered, glabrous, and about a foot high; its flower is large, bell-shaped, and of a fine scarlet-crimson colour, with a broad, black, yellow-edged spot at the base of each sepal, and blooms in April and May; its exterior sepals are acuminate, and the interior ones obtuse; and its stamens are smooth.

The sweet-scented or early dwarf or Duc Van Thol tulip, *T. suaveolens*, is a native of the South of Europe, and was introduced thence to Britain in 1603. Its leaves are ovate-lanceolate; its stem is one-flowered, downy, and about 6 inches high; its sepals are obtuse and smooth; and its flowers are sweetly fragrant, and have a scarlet colour edged with yellow, and are valued far more for their odour and their earliness than for their form or appearance, and naturally bloom in March and April, but when grown in a room in either sandy soil or water, may be made to bloom as early as January.

The creeping Russian tulip, *T. repens*, was introduced to Britain from Russia in 1819, and is a foot high and yellow-flowered, and blooms in April and May. The horned tulip, *T. cornuta*, was introduced from the Levant in 1816, and is two feet high and striped-flowered, and blooms in May. The starred tulip, *T. stellata*, was introduced from Kumana in 1827, and requires frame protection, and has a height of between 30 and 36 inches, and carries white flowers, and blooms in March and April. The rock tulip, *T. saxatilis*, was introduced from Crete in 1827, and is a foot high and yellow-flowered, and blooms in April and May. Bieberstein's tulip, *T. Bieberstieniana*, was introduced from Siberia in 1820, and is a foot high and yellow and purple flowered, and blooms in June and July. The bad-smelling tulip, *T. maleolens*, was introduced from Italy in 1827, and is a foot high and red and yellow-flowered, and comprises a variety with red and variegated flowers, and blooms in May. The Altaian tulip, *T. altaica*, was introduced from the Altai Mountains previous to 1830, and is a foot high and yellow-flowered, and blooms in April and May. The rough-stemmed tulip, *T. scabriscapa*, was introduced from Italy in 1827, and is two feet high and red and yellow-flowered, and blooms in April and May. The middle tulip, *T. media*, was introduced about 1830, and is a foot high and scarlet and white flowered, and blooms in May and June. Bonarota's tulip, *T. Bonarotiana*, was introduced from Italy in 1827, and is about 18 inches high, and has red and variegated flowers, and blooms in April and May. The three-coloured tulip, *T. tricolor*, was introduced from Russia in 1817, and is a foot high and scarlet-flowered, and blooms in April and May. The pubescent species, *T. pubescens*, was introduced in 1824, and is a foot high and red-flowered, and blooms in April and May. The Turkish tulip, *T. turcica*, was introduced at a considerably distant but uncertain period, and is two feet high and striped-flowered, and blooms in April and May. The early-flowering tulip, *T. præcox*, was introduced from Italy in 1825, and is a foot high and scarlet-flowered, and blooms in April and May. The mountain tulip, *T. montana*, was introduced from Persia in 1826, and is a foot high and scarlet-flowered, and blooms in July. The choked tulip, *T. strangulata*, was introduced about 1830, and is about 18 inches high, and blooms in April. The spreading tulip, *T. patens*, was introduced from Siberia in 1829, and is about a foot high, and has white and grey flowers, and blooms in April and May.

Gesner's tulip or the common garden tulip, *T. Gesneriana*, was the earliest known of all the species; and has probably received more attention from florists than any other plant in existence; and is diffused throughout almost all the gardens of Europe, small and great; and often monopolizes the entire name, and usually concentrates in itself the main interest, of the whole tulip genus. Its leaves are ovate-lanceolate, glaucous, and smooth; its stem is one-flowered, smooth, and commonly from 10 to 30 inches high, varying widely in different varieties; its flowers are normally striped, but sport into multitudinous and highly diversified colourings, and bloom in April and May; its sepals and filaments are smooth; and the lobes of its stigma are decurrent and deeply divided. There are five very distinct varieties of it, serving as types or representatives of so many groups of innumerable subvarieties;—the normal, *T. Gesneriana*, from 20 to 30 inches high, with striped flowers; the yellow, *T. G. lutea*, from 15 to 24 inches high, with yellow flowers; the double, *T. G. plena*, from 10 to 16 inches high, with variegated flowers; the party-coloured, *T. G. versicolor*, from 15 to 24 inches high, with variegated flowers; and the cut-sepaled, *T. G. laciniata*, from 20 to 30 inches high, with variegated flowers.

The garden tulip grows wild in Syria and in other countries near the eastern parts of the Mediterranean; it was cultivated by the Turks, from an early period, in their gardens; it was introduced to Western Europe from Constantinople in 1554, and was first described, in a systematic way, by Conrad Gesner in 1559; and it was introduced to Britain in a general way about 1577, and re-introduced in its finer forms in 1603. When it was introduced to Holland is not pre-

cisely known, but it early made a profound impression in that country, and began to be cultivated with an enthusiasm, which speedily rose into the famous tulipomania. This was originally a violent and spendthrift passion for the newest and finest varieties of the tulip; and it eventually became, and for some time continued, a system of gambling speculation, in which tulip-bulbs were sold at enormous prices, somewhat in the manner of the transactions of the Stock-Exchange; and it rose to its greatest height in the four years succeeding 1633. The bulbs were sold by weight, in perits or grains; and some brought prices which would have purchased a small estate. "The variety called Semper Augustus," Beckman tells us, "was often sold for 2,000 florins; and it once happened that there were only two roots of it to be had, the one at Amsterdam, the other at Haarlem. For a root of this variety one agreed to give 4,600 florins, together with a new carriage, two grey horses, and a complete harness. Another agreed to give twelve acres of land for a root. Those who had not ready money promised their moveable and immoveable goods, house and lands, cattle and clothes." The traffic in tulip-bulbs engaged men of all ranks, and absorbed more attention than any department of useful commerce, and organized itself into a regular system, and occasionally worked out for some of its votaries prodigious profits, and terminated in such general, rabid, and destructive gambling that the Dutch government felt obliged to interfere with it and put it down. In one instance, it brought a profit of more than 60,000 florins to one dealer in four months; and in multitudes, it was pursued with such reckless disregard of principle and decency, that a bulb was sold several times or even many times over without being seen or possessed by any of its purchasers. "It was followed," says Beckman, "not only by mercantile people, but also by the first noblemen, citizens of every description, mechanics, seamen, farmers, turf-diggers, chimney-sweeps, footmen, maid-servants, and old clothes-women. At first, every one won, and no one lost. Some of the poorest people gained in a few months houses, coaches, and horses, and figured away like the first characters in the land. In every town some tavern was selected which served as a Change, where high and low traded in flowers, and confirmed their bargains with the most sumptuous entertainments. They formed laws for themselves, and had notaries and clerks. During the time of the tulipomania, a speculator often offered and paid large sums for a root which he never received, and never wished to receive. Another sold roots which he never possessed or delivered. Oft did a nobleman purchase of a chimney-sweep tulips to the amount of 2,000 florins, and sold them at the same time to a farmer; and neither the nobleman, chimney-sweep, nor farmer had roots in their possession, or wished to possess them. Before the tulip season was over, more roots were sold and purchased, bespoke and promised to be delivered, than in all probability were to be found in the gardens of Holland; and when Semper Augustus was not to be had, which happened twice, no species perhaps was oftener purchased and sold. In the space of three years, as Munting tells us, more than 10,000,000 florins were expended in this trade, in only one town of Holland." The tulipomania was ridiculed and despised by calm observers in other lands, and has ever since been proverbially quoted as a marked instance of the epidemic folly which sometimes assails a whole community; and when it passed away, it afforded ignorant pretenders and indolent aristocrats a feasible pretence for neglecting or deriding all floriculture, and especially tulip-culture, as undignified and foolish. Another mania, therefore, arose, more gross and irrational than even the tulipomania, calmer indeed and clothed with more trappings of worldly rank, yet incomparably more grovelling and brutal,—the mania of treating with indifference or contempt, or of denouncing as suitable for only the uneducated and the vulgar, one of the most beautiful and heaven-proclaiming objects in the vegetable world. But this mania also is becoming obsolete; and the tulip—probably both the superbest and the truest "lily of the field"—is now very generally allowed to occupy its just place as a meek and lowly yet most magnificent instance of the beauty which pervades all God's works,—more gorgeous than "Solomon in all his glory," challenging the admiration of all eyes, and directing to heaven the kindlings of all hearts.

The innumerable varieties of the garden tulip are usually classified by British florists into selfs, bizarres, byblomens, roses, and tricolours. A self is all white or all yellow, or at least has a predominant ground-colour of white or yellow, without any distinct markings. A bizarre has a yellow ground colour, marked with any one of many different shades of purple or scarlet; and may be either a feathered bizarre or a flamed bizarre, according as the colours are in filaments and pencillings or in a broad central stripe. A byblomen has a white ground colour, marked with lines, stripes, or variegations of any one of various shades of purple or violet; and it also may be either feathered or flamed. A rose has a white ground colour, marked with lines, stripes, or variegations of any one of various shades of rose, scarlet, cherry-colour, or crimson; and, like each of the two preceding, it may be either feathered or flamed. Tricolours do not properly constitute a separate class; but comprise all tulips, but especially all bizarres, which have three colours.—The tulips of the old British gardeners were classified sometimes into early-bloomers and late-bloomers, and sometimes into early-bloomers, middle-bloomers, and late-bloomers; but they comprised rather species than varieties, — or rather, the early bloomers were principally iden-

tical with *Tulipa suaveolens*, and the late bloomers with *Tulipa Gesneriana*.

During the time of the tulipomania, and even in a considerable degree in the succeeding times down to the present day, a prime or a good tulip was not necessarily a very beautiful one, but simply a very rare one; but, in all the sober schools of modern floriculture, it is essentially and even eminently beautiful in both form and colour, whether it be rare or common,—and according to general consent, it must possess the following characters:—"The stem should be strong, elastic, and erect, and about 30 inches above the surface of the bed. The flowers should be large, and composed of 6 sepals or petals; these should proceed a little horizontally at first, and then turn upwards, forming almost a perfect cup, with a round bottom, rather widest at the top. The three exterior petals should be rather larger than the three interior ones, and broader at their base; all the petals should have perfectly entire edges, free from notch or serrature, the top of each should be broad and well rounded; the ground colour of the flower, at the bottom of the cup, should be clear white or yellow, and the various rich-coloured stripes, which are the principal ornament of a fine tulip, should be regular, bold, and distinct on the margin, and terminate in fine broken points elegantly feathered or pencilled. The centre of each leaf or petal should contain one or more bold blotches or stripes, intermixed with small portions of the original or breeder colour, abruptly broken into many irregular obtuse points."

A self-tulip is always raised from seed; and under suitable circumstances of soil and age and management, may give rise to one or more fine varieties of either bizarre, byblomen, or rose. A breeder is a choice self, from five to nine years of age, from the seed, still vigorous, tall, and elastic in the stem, beautifully formed in cup and sepal, of an uniform colour on both surfaces, of a pure white or bright yellow in the bottom, and either black or dark in the anthers and stigmas; and if it be properly grown, and judiciously treated, and perseveringly cared for, it will sooner or later "break" into a bizarre, or a byblomen, or a rose,—or in other words, develop the colours and markings of one of a variegated and richly tinted variety. But a breeder of any of the three classes is not a breeder of either of the other two; some breeders break in the very earliest years of blooming, and others not till after a number of years, perhaps so many as twelve or even twenty; and the variegated offspring of some have a tendency to revert to the breeder characters, while the variegated offspring of others are absolutely or comparatively permanent, and have been known to transmit their acquired characters, through the medium of their offset-bulbs, with very little variation, for nearly half a century. The influences most favourable to the sure and brilliant breaking of breeders are not well understood in Britain, and have been the topic of much conjecture and discussion among florists, and may best be studied by careful enquiry into the practices of the most successful tulip-growers of Holland.

An easy and efficient method of obtaining valuable breeders, and even some splendid broken flowers, from 150 or 200 seeds, in a period of from 5 to 7 years, is detailed as follows by a writer in the Gardener's Gazette:—"In November, take a common twelve-sized pot; put about 1 inch or 1½ inch layer of crocks, and fill up the pot with a rich light compost, tolerably free from stones, such as would be used for carnations; shake it down a little, and level the top even with the edge of the pot. Spread the seed on this; plunge it in the ground up to the rim of the pot, as the earth settles down, by watering, and sift the same kind of compost on the seeds, covering them to half an inch in depth and not more. When they come up, sift the same kind of light rich earth upon them; for, without doubling down the grass, it will raise the soil above the embryo bulbs. The heat of the sun and the extreme of the frost must be kept from the plants, no matter how; the one or the other would stint the growth, if not kill them; nor must they ever be dry. When the grass has turned yellow, sift the mould through a small sieve, and collect your bulbs; or if they be not very near together, you may allow them to stand a second year; but they grow larger when taken up, and kept out of the ground a short time. In October plant them again in pots, an inch apart, and sink them as before. Take them up as before. The third year plant them again in October, two inches apart in the row, and two inches deep, in a properly prepared bed of rich earth, and let the rows be six inches apart. Here they must have a foot, at least, of good soil, free from large stones, and be kept very clear from weeds. When they die down, they must be taken up again. The fourth year they must be planted three inches apart in the row, and three inches deep, and be taken up as before, when the foliage is decayed. The fifth year, plant the bulbs four inches apart, in good compost, as before, and in October. This year many will bloom, of a self colour. If they have thin petals, pointed petals, foul bottoms, or are of a bad form, throw them away before they have done blooming—it prevents mistakes—and throw away all their offsets at the same time. If they have thick petals, round at the ends, forming a good cup, and having a clean yellow or white bottom, mark them to be kept separate from that season onwards, and place them, on taking up, in separate bags or boxes with their increase; so that, when any one breaks into colours, the whole of that variety may be either saved or destroyed, as they may deserve."

The matured bulbs of selfs, and all bulbs of bizarres, byblomens, and roses, succeed best, and

produce the most showy results, in specially prepared beds. The situation must be open and airy; the ground should be dug out to the depth of about 20 inches; the excavated space should be filled with a compost of about one part of well rotted cow's dung and about two parts of rich, fresh, loamy, somewhat sandy soil; and the bulbs should be deposited at distances of about seven inches from one another, and at a depth of four inches or less according to their size. A sprinkling of fine dry sand may be put on the site of each bulb; and as much of the same material may be sprinkled over the bulb as might prevent the coherence to it of moistened soil. The best time for planting is from the first till the tenth day of November. The collocation of different classes of flowers may be done to suit the cultivator's personal taste; but that of different heights of stem should be in the successive rows,—the shortest in the front, and the tallest in the rear; and in order to facilitate this arrangement, all fine varieties, previously not known to the cultivator, ought to be described to him as of the row, whether first, second, third, or fourth, to which they are suited. An awning may be erected over the bed in spring, after the nascent flowers begin to show colours; but should be so constructed as to permit the free play of light and air during all the morning and the evening, between the extremes of midnight cold and mid-day sunshine. No artificial watering ought ever to be given. As soon as the petals fall, the incipient fructification ought to be cut away; when the leaves become embrowned, and the top of the stem begins to wither, the bulbs should be unearthed, and placed in a dry situation; and in August or September, the bulbs may be freed from their fibres, loose skins, and young offsets, and stowed away in drawers.

The fine varieties of garden tulip at present in cultivation are exceedingly numerous, and amount at least to five or six hundred; yet some of the most common bear a number of different names, and falsely pass in many catalogues for as many kinds as they have names,—and some of the least common are eminently beautiful, and owe their uncommonness rather to want of fashion than to real scarceness. A brief notice of a few of the principal varieties, therefore, may serve the double purpose of acting somewhat as a check upon the market catalogues, and of guiding novices in amateur culture to the making of a pre-eminently good small collection.

Polyphemus, a very common but first-rate bizarre, suitable for the second and the third rows, bears many names, and is sold under most or all at different prices. The ground colour of it is rather pale yellow, the markings are dark and good, but often too heavy; the form pretty nearly the best; the petals lying so close as to form a whole cup; in general the purest of the bizarres, but ugly in its breeder state, and when it has gone nearly back. The bottom, however, is never stained, but the colour of the anthers occasionally runs a little down the stamens. This would be a blemish if compared with one which was not so; but coloured stamens is not a disqualification like a stained bottom.—Captain White, Sanzoe, Captain Black, or Admiral Black, is one of the most beautiful bizarres, in several respects the best, and belongs to the second row. The yellow is exceedingly rich; and the marking greatly varied in style, but nearly always splendid. This flower is above the average in form, though not equal to Polyphemus in compactness and neatness of construction; yet it very rarely occurs without three very slight stains at the base of three of the petals, so slight that hundreds would overlook them.—Surpass Catafalque is a bizarre of great pretensions as to form, and probably excels in that respect all our present varieties. It belongs to the second and third rows. The yellow is not so fine, and the marking not so dark as in many others; but, well grown, it is a fine show flower, quite pure, often very neatly and perfectly feathered. It is also very plentiful and cheap.—Charbonnier Noir is a very pure bizarre, with very bad marking; that is to say, there is great uncertainty. It is very apt to come with portions of the breeder colour, so much so, as to scarcely afford one showable or well-marked bloom in twenty; but, when perfect, it is a most splendid bizarre, with fine, but pale yellow, splendid bottom, and not a bad form. It so rarely comes in perfection that good specimens of it have borne other names as if they were distinct varieties.—Pompe Funebre is a bizarre of great price and pretensions, but of quite second-rate, if not worse, form. The yellow is brilliant, and the marking generally pretty and always effective. The flower is in repute, but is a very unsafe one to show in a stand, if the judges go in earnest at the properties; for it must lose every point in regard to form.—Brown's Polyphemus is as compact as the original Polyphemus, but higher on the sides, so as to form a rather longer cup. The yellow is deep and rich; the marking darker than in any other,—in fact, as nearly black as it can be when in good order. It appears rather a constant flower; and rises well up to the fourth row when full grown, and the third when comparatively undersized; and it is at present one of the dearest varieties in the market.—Thomas Brown is a bizarre of the fourth row, fully as noble as the last mentioned, but different. The flame is large; the yellow a good gold colour; the marking very striking; feather and flower too; and generally the colour outside better than that of many others. The size is above the average, and remarkably showy in a bed; a half-grown root will reach the third row.—Lawrence's Duke of Clarence comes in twenty different characters, and has had as many names. It is one of those indistinct and eccentric flowers which, besides changing character, actually change colour; sometimes a bright yellow and dark markings, but the outside always dull, and a struggle between a dirty white and a straw colour; and the markings not half defined, even when the inside is tolerable. The inside is sometimes a good, though not a brilliant yellow; but the outside is never bright. It is, however, a bold middle-row variety; and possesses a medium character between a bizarre and a tricolor.—Leonatus Posthumus is singular but not splendid, curious but not beautiful. It has almost always a flame without feather, a brown and yellow, with nothing strikingly good to recommend it; and its chief merit is that of differing in colour and character from all the old bizarres. It grows, according to the size of the root, in the first, second, or third row; and is quite clean, but not of very good form.—Solon is a first, or, at the most, second-row bizarre, of better form than the preceding, showy, with good yellow, and very often highly uniform marking; frequently flame without much feather,—sometimes without any. It makes a striking flower in the first row, because the flower is large in proportion to the height. The yellow is palish, but very pretty and bright.—Lord Colling-

wood is a very tall bizarre, which has been held in very high estimation. It has a singular colour and character about it, unlike any other bizarre,—a singular purple cast in the marking; and always brings a high price. It is in most good beds. It is tall even for the fourth row, mostly topping all others. The flower, however, is small for the height of the stem, and it is not very certain as to the marking.

Rose Emily is a showy, clean, middle-row flower, of tolerably certain character; always pretty, sometimes very fine; with a tolerably thick petal, clear white, and frequently well-defined marking. It is not plentiful, and therefore pretty high in price. Smaller roots do for the third row: but it should never be had in the second, for it will run up.—Rosa Blanca is a beautiful flower, and curiously sports into two very distinct subvarieties. One of these is beautifully and regularly feathered, and without any flame; and the other is richly feathered and flamed. The two are the same flower in different characters; and any body who grows the feathered kind will find in time that he will obtain the other, though the feathered and flamed kind does not go back to the lighter character. The flower is a showy subject in a bed; yet it blooms too early for the rest of the bed, —and after it has been out some days, its beautiful rose colour goes off to a light purple, and so distinct as to enable a stranger to pronounce one a byblomen, the other a rose. It is a good third-row flower, and is occasionally used as a fourth-row flower; but is very apt to split and form two roots instead of blooming; on which account two bulbs of it may be planted in the same hole.—Madame Vestris, in its best state, is a feather only, and one of the most rich and beautiful roses; but it more frequently comes full of flame and feather, in which state the colours are not so bright. It is a showy variety, very pure, very distinct from all others, and an excellent marker for the country shows. When it comes with feather only, it seems as if the same quantity of colour that would be used for all the flame and feather were concentrated in the feather only, it is so dense and rich. In this state it was called Princess Sophia of Gloucester; but a few seasons' growth settled the question, and Madame Vestris is unquestionably the identical flower, although the colour is so much deeper while feathered only. It is a second-row flower, but has been occasionally put into the third. —Triumph Royal is one of the best roses, though abused as much as any by new names when in different characters. It varies from the slightest possible feather to the deepest flame and feather. It is always beautiful, and deserves, however plentiful it may be, and however cheap, to take its stand among the very best class of roses. It is very pure, and its shape is far above the average.—Camuse is beautiful in a bed, but, on account of its form, cannot be safely admitted into a stand for show. The petals are always three one way and three the other; and the three inner ones turn in, while the outer ones keep expanded more. It is a very pure and richly-coloured rose, stands well as a second-row flower, and is always handsomely marked. There is a difference of opinion as to whether Camuse and Brilliant are the same flower; the only perceptible difference being, that Brilliant is full of splashes of red colour, as if it had been sprinkled with a brush; while in form, colour, purity, grass, and all other particulars, they are alike. It is said, however, that Camuse never comes speckled, and Brilliant never comes pure.— Rose Esther, according to a specimen of it exhibited in 1833 at Hampton, is one of the most perfect things that can be imagined. The ground, or white, is of a singular texture; it is not clear white, but a sort of shade, like enamel, and as clear and apparently transparent. A flame up each petal, alike in all six petals, a close cup, rather taller than it ought to be, the bottom as pure as possible, and the whole as perfect a beauty as can well be imagined. Yet this exquisite specimen was but one of those freaks which flowers will take in spite of florists, and which are rarely equalled. The flower is naturally coarse and foul at the bottom; and in some seasons there has not been one clear bottom in twenty.—Lady Crewe is a small rose, often very beautifully marked, and frequently smudged at the bottom, but occasionally as clean and pure as snow. It is a brilliant colour, and, in its feathered state, when there is no flame, quite a little star in the outside row. The petals are too narrow to allow its full expansion; and, indeed, like many country flowers, it seems very unwilling to open fully. Its brilliance, as compared with some roses, is greatly enhanced by the colour on the outside being nearly as good as the inside; but even this is secured by a disadvantage, the comparative thinness of the petals.—Claudiana is a most beautifully coloured rose, good large flower, blooming egg-shaped, and not fully expanding, the petals never losing their individual boat form. This flower, though quite desirable in every bed, is an awkward one to show; for it is seldom to be found without a blue stain on the shoulder among the other colours. It is a third and fourth-row variety; and a dozen would not look too many in any moderate-sized bed. —Catalani is a second and third-row flamed and feathered rose, of extraordinary rich colour, firm petal, pure white; and, besides these qualities, has the advantage of being a free opener. It is a great favourite, and always assists a bed materially; but has been often unjustly confounded with Ceres Blanche and Ponceau Très-blanc.—Lac is a very high-priced rose, and deservedly a favourite, for its extremely brilliant colour. It is a first-row flower, of the full size for its height, but with much too thin a petal. When put on a stand, the place it rests on is seen through enough to cast a dark shade; and this is a sad drawback. Its colour approaches a scarlet; and when it first opens, it is a most beautiful object in a bed.—Rose Catharine, or Athalia, is a rose remarkable for its beautiful and very striking colour, rarely coming perfectly free from a stain in the bottom, and yet so desirable as a bad flower, that nobody of any taste would be without it. The lighter it is marked, the clearer it usually is in the bottom, and the brighter is its marking developed. It is a second row rose; and a few of it in a bed impart great brilliancy.—Camuse de Craix is a very delicate and handsome rose, with a straw-coloured ground, and rich crimson scarlet markings. It is justly esteemed as a star in the first row, and the markings are generally very uniform, and have splendid pencilling. When perfectly bloomed, the appearance is very grand indeed; though it is some days in coming to its proper colour.—Ceres Belleforme is a very compact and beautifully marked rose for the first or second row, but most proper for the first. It opens rather yellow, but bleaches white. The cup does not very much expand, but there are many good points to make up for it. The petals are so well together, that, like Polyphemus and Salvator Rosa, they are like one petal instead of six; and the colouring is always beautiful in all its characters.

Louis XVI. is a very noble byblomen, but a most uncertain one. The white is good, and the marking a deep purple, almost black when in fine condition. The colour is very apt to run down too low, and the bottom to come smudged; and out of a score of Louis XVI. in a bed, there will be times when not one flower would be fine and clear as it ought to be; yet, for the sake of a bloom now and then, everybody grows it. There are what the growers call different strains of it, which means that some flowers and their offsets are generally better than others,

although the same variety. The flower, in all its stages, is striking in a bed, and, when perfectly free from breeder colour, is rich and handsome. It will do for the third or the middle row, according to the size of the root.—Siam is a third or fourth row byblomen, of excellent properties, fine white ground, and purple margins, petals thick, form above the average; but the bottom is yellow for the first period of the bloom, and that condemns it all the early part of the season; and though it bleaches very fine, it must have years before the bloom is off. It has been grown in high character by come cultivators; and, under a notion that the strain was improved, it was called Acapulca.—Reine de Sheba is a very neat thick petalled byblomen, with good white pure bottom, generally well flowered and feathered outside, a second-row flower, rather of the smaller kind. The purple is rather light, the markings generally perfect, or nearly so. The form, though not first rate, is above the average of the old flowers.—Violet Alexander or Violet Quarto is a middle or third row byblomen, exceedingly pure at the bottom, when in condition, apt to sport in the colouring and to have breeder colour, but when fine, a most delicate and beautiful variety.—Ambassador d' Holland is a noble black and white middle-row flower, which has pretty universally a stained bottom, with a dark creamy stain. It has a good bold size, and deserves a place even in best beds, notwithstanding the drawback of its creamy bottom; and its form is good among the large varieties.—Washington is a bold deeply-coloured byblomen, with thick petal, good white and clean bottom; though three of the petals rise above the others. It has been long a favourite; and will go in the second and third rows.—Lawrence's Friend is a very pretty byblomen, with a good deal of colour. At first coming into flower, it is like a tricolor; but it always bleaches white, or nearly so, and the flower, though smaller, and taller in the stem, is very much like a handsome Washington. There is the same characteristic in the separation of the top and bottom petals.—Desdemona is a middle-row, light-coloured byblomen, not always clean, or perfectly marked, but very showy and desirable. The cup is rather long; but in the middle and third row, forms a pleasing feature.—Salvator Rosa is a magnificent byblomen, with nearly all the characteristics of a Polyphemus bizarre; a close, well-formed, compact cup, and pure white, deep purple colours. The petal is thick, the ground pure, and the colour rich. It is a second-row flower, of good average size, and a star in any bed that has it.—Rubens is a rich byblomen of the second or third row, average size, deep fine purple, pure white, clean bottom, nearly as showy as a Louis, and always good in a bed. The form of the cup is not so good as that of some of the more modern flowers, the petals being rather inclined to narrow at the ends; yet it is a noble and desirable flower, and maintains its station in all good beds.—Thalia is a very grand byblomen, with compact, well-formed, but not much expanded cup. The white is exceedingly pure and clear to the bottom; and the bloom is above the average size, and a good deal above average quality. The petals are remarkably thick; and the height is equal to the middle row. It is in all respects a desirable flower; though apt to mark irregularly, until reconciled to the treatment it is undergoing.—Alcon is a large middle row byblomen, clean but loose, and showy but not neatly made. The cup is rather long than otherwise.—Grand Monarque is a third or fourth row byblomen, very showy, but not always pure in the bottom. It is generally feathered strongly, and forms a good feature in a bed. The cup is rather loose, and the white good; yet the flower is not much valued.—Lord Hawkesbury is a very fine looking byblomen, fit for the third row, pure white, long cup, fine purple, and the flower altogether showy, and in a bed desirable.

TULIP-TREE. See Liriodendron.

TUMBREL. A manure cart. The body of it is $4\frac{1}{4}$ feet long, $3\frac{3}{4}$ feet broad, and $2\frac{1}{4}$ feet deep; the wheels are $5\frac{1}{2}$ feet in diameter and six inches broad; and the shafts are fixed, and, in unloading, are lifted into the air. Two horses in line draw the machine,—the trace-horse by the ends of the shafts, and the thill-horse by short traces fixed at the other ends. The tumbrel has a heavy construction and a lumbering motion, and serves no better purpose with two horses than a well-constructed common cart does with one. It is used principally in Norfolk and some of the midland counties of England.

TUMBREL, or Tumbril. A machine used, principally in Lincolnshire, for supplying sheep with artificial food in winter. Its body is a circular cage or crib, about 10 feet in circumference; and is closely wattled to the height of about one foot, and is left unwattled or merely staved immediately above the wattling to the height of about 18 inches, and is then wattled again to the height of about 8 or 10 inches, and is finally left quite open at the top to the breadth of about 18 inches for putting in roots or hay or other sheep-food. The staves are 10 inches asunder, and allow twelve sheep to feed simultaneously at each tumbrel; and the wattling is done with willow, osier, or any kind of pliant brushwood.

TUMOUR. A topical and irregular enlargement in the root, stem, branch, bud, or leaf of a plant. It arises in some instances from obstruction in the ascent of the sap, but in most from puncturing by insects in the deposition of their eggs. Some of the most common instances of it are clubs on the roots of brassicas, knots and bunches on the stem and branches of oaks and elms, and excrescences and galls on the buds and leaves of various common trees and shrubs.

TUMOUR. Any chronic swelling or hard abscess on any part of an animal's body. Some tumours are caused by bruises and other accidents; and some by interior disturbance of the system, by a corrupted state of the fluids, by general debility of constitution, or by various kinds of atmospheric influence and agency; and many which originate in widely different ways, have a widely different character, and require a widely different treatment. Tumours which are much inflamed, but do not tend to suppuration, should be treated with cooling applications, such as a solution of sugar of lead or a lotion of Goulard's extract in water; inflamed tumours which tend to suppuration should be accelerated toward a crisis by means of fomentations and poultices; hard indolent tumours, which are neither inflamed nor painful, but either simply inconvenient, or precursory of some worse development, should be roused to activity by rubbings of stimulating liniment, stimulating

ointment, or even blistering ointment; and very hard or quite inert tumours of the nature of wens can be properly removed only by excision. See the article Abscess.

A topical and somewhat specific disease in the throat of cattle has no more distinct name in veterinary nomenclature than tumour. This disease varies in appearance, virulence, and general character in different districts and different seasons; and, in the form in which it commonly occurs in the southern parts of Scotland, is popularly called Clyers in the throat. It arises sometimes from atmospheric influences, and sometimes from coldness and bleakness of situation, but much more frequently from breeding in-and-in, or from other causes and practices which debilitate the constitution. It is occasionally so prevalent on particular farms or within limited districts as to look like an endemic; but it more frequently occurs so scatteredly among flocks as to appear to have an independent development in each of its subjects. It possesses considerable analogy to strangles in horses, but is somewhat more difficult of treatment, and more fatal in tendency. It seems to be generally connected with a weak or depressed state of the entire system; and, on this account, instead of proceeding to suppuration and forming a freely-discharging abscess, as strangles do in horses, it often assumes an indolent state, and makes but a trifling discharge from different points, and afterwards either forms sinuses, or undergoes a partial absorption of matter and passes into the condition of a hard tumour. It at all times affects the breathing of its subjects, but does not prevent their feeding till the act of deglutition is rendered painful by the great enlargement on the throat. Young heifers are more liable to it than any other kind of cattle, and are unfitted by it for breeding. Any animal affected with it should be confined in a comfortable shed or house; the strength of the system should be increased by means of a nutritious diet combined with tonic medicines, such as the sulphate of iron, in doses of 2 drachms to a middle-sized two or three year old, once a-day, in a little gruel, or 5 grains of iodine in gruel night and morning. The tumour should be laid open if matter is to be felt; but if not, a blister should be well rubbed into the surface of the swelling, and repeated until there is either absorption of the tumour, or the formation of an abscess. Should this plan not answer in raising an energetic action in the tumour, iodine in the form of ointment, in the proportion of 2 drachms of it to 4 ounces of lard, should be well rubbed into the tumour every day until absorption takes place. If the tumour resist these remedies, it should be freely cut into with a lancet, and a little tow put into the wound twice a-day, smeared with blistering ointment, or dipped in a strong solution of sulphate of copper. In the early stages of the disease in those animals which seem to have a comparatively robust constitution, it may be worth while to try what can be done to stop the progress of inflammatory action by bleeding and purging; and in places where the disease assumes an endemic character, and works much havoc, it may become worth the consideration of the proprietor or farmer, where no other plan of prevention can be attempted, to try the slow but sure remedy of belts of planting, so disposed as to protect both the cattle and the crops, and thereby improve the land for every kind of agriculture.

TUNA. See Opuntia.

TUNA-TREE. See Bastard-Cedar.

TUNGSTEN. An elementary metallic substance. It does not naturally occur in an uncombined state; but may be artificially obtained by the action of charcoal or of dry hydrogen at a red heat on tungstic acid. It has a greyish-white colour, a considerable lustre, a considerable brittleness, nearly as great a hardness as steel, a less fusibility than manganese, and a specific gravity of about 17·4. Tungstic acid consists of one atom of tungsten and three atoms of oxygen; and may be readily obtained by prolonged digestion of very finely levigated native tungstate of lime in nitric acid, or by raising the dark brown oxide of tungsten to a red heat in open vessels, or by the action of hydrochloric acid on walfram, the native tungstate of iron and manganese. It is a yellow powder, insoluble in water, and has no action on litmus paper, but combines with alkaline bases to form salts; and when strongly heated in open vessels, it becomes green,—and when acted on by hydrogen at a temperature of between 500° and 600° Fahrenheit, it becomes blue, and is supposed to be changed into a tungstate of the oxide of tungsten.—The dark brown oxide of tungsten consists of one atom of tungsten and two atoms of oxygen; and may be obtained either by an operose process with walfram or by the action of hydrogen at a low red heat on tungstic acid; and when obtained in the former way, is almost black,—in the latter way, brown and capable of taking on a copper colour by polishing. It does not combine with acids; and when heated to redness, burns and passes into tungstic acid.—Tungsten combines in three proportions with chlorine.

TUP. A ram.

TUPA. A genus of ornamental exotic plants of the lobelia family. The charming species, *T. blanda*, is a perennial-rooted, annual-stemmed, pink-flowered herb of about 3 feet in height, from Chili; and the other species are very diversified,—and, in several of the most remarkable instances, formerly ranked as true lobelias. See the article Lobelia.

TUPELO. See Nyssa.

TURBARY. A piece of bog out of which peat-fuel is cut. See the articles Bog and Peat.

TURF. The sward of grass-lands; also the peaty portion of bogs. In the former sense, it is discussed in the articles Grass Lands, Pas-

TURE, and PARING AND BURNING; and in the latter sense, in the articles BOG, PEAT, FUEL, and HEATHS.

TURF-ASHES. See ASHES.

TURF-BOG. See BOG.

TURF-SPADE. See BREAST-PLOUGH and PEAT.

TURGESIA. A genus of ornamental, South-African, herbaceous plants, of the crassulaceous order. Three perennial and four biennial species, varying in height from 6 to 15 inches,—one of the biennials red-flowered, and all the others white-flowered,—have been introduced to Britain; and all love a soil of sandy loam, and require the protection of the greenhouse.

TURKEY,—scientifically *Meleagris*. A genus of birds of the gallinaceous order. A plumeless and papillated skin invests the head and the upper part of the neck; an appendage dangles under the throat, and hangs along the neck; another appendage of a conical form surmounts the forehead, and, in the male, when he is excited to anger, becomes so inflated and elongated as to hang over the point of the beak; a tuft or tassel of stiff hairs hangs from the lower part of the adult male's neck; the coverts of the tail can be erected and displayed in the same manner as in the peacock, but are shorter and stiffer; and the tarsi of the male are armed with weak spurs.

The common turkey, *Meleagris gallo-pavo*, was for a long time the only species known. It is a native of the West Indies and of Continental America, and was introduced to Europe in the 16th century; and in consequence of its ready domestication, its great size, and the excellence of its flesh, it soon became very common, and has long occupied the rank of a higher order of domestic poultry. The wild variety of it in most parts of America has a greenish-brown colour, with a copper gloss; and the black subvariety of our domesticated kinds, is the best for both size and delicacy.

The ocellated turkey, *Meleagris ocellata*, was first found at the bay of Honduras, and seems to have very distinct specific characters. Its general plumage is remarkably brilliant, and almost equals that of the peacock; and its tail-coverts, which are similar in shape to those of the common turkey, are adorned with sapphire-coloured spots, surrounded with circles of gold and ruby.

Turkeys are very clean birds; they love sweet food and abundance of free air; and they prefer to roost in trees, and hop gradually up from the low branches, and find shelter among the boughs from frost and winds. An evergreen tree, such as a yew or a spruce-fir, is a very suitable piece of furnishing in the yard or compartment of the farmery allotted to them; and where this is a-wanting, special artificial provision should exist for large grasp in perching, for profuse ventilation, for perfect constant cleanliness, and for dryness and warmth in winter and coolness in summer. The hen seeks secluded nesting ground, and often strays far from home, and commonly requires to be watched and manœuvred. The number of her eggs in a season is only from twelve to twenty; and each, when newly laid, should be taken away from the nest, and substituted by a piece of chalk closely resembling it in size and form and appearance. When she shows a desire to sit, she should be cooped upon her eggs in the turkey-house; and while she is sitting, she ought never to be disturbed. No turkey should be allowed to sit twice in one season. The newly-hatched birds should be kept for some time in the nest, and maintained in a warm and dry condition, and never handled or in any way artificially treated; and, when they develop the red colour of the head, they may be regarded as safe from the diseases of their infantile state. Young turkeys should be fed three or four times a-day with a pultaceous mixture of fine barley meal and dock leaves, or of barley meal and chopped onions, nettles, and potherbs, but especially, if they can be had, with ants' eggs. Nothing, however, contributes more to advance their growth, and insure their health, than the seeds and insects they pick up in long grass. Yet as the hen is very inconsiderate, and, with the intention of procuring them abundance of these, will roam far away beyond the strength of her progeny, and, so that she is accompanied by some of the hatch, is regardless of the weaker ones, it is good policy to pen her upon a lawn, under a crate, such as earthenware is packed in, so that the chicks can roam about, and return to her call when any danger approaches; and here the food of the young birds, which she would gobble up, can be placed out of her reach. More advanced turkeys thrive best when allowed to roam through meadows, and cater for themselves by the sides of hedges; but they must be fed in the mornings and evenings, or when they return toward home, which they will soon learn to do periodically when they require food. They must, however, be watched on their excursions, by a boy or girl, who should on no account drive them, but merely follow their motions, bringing them home in good time in the afternoon. As turkey-cocks are very pugnacious animals, and, moreover, often destroy the young ducks, we would not recommend one being kept. They often terrify children, and will sometimes attack visiters approaching a house; and at the same time, they are neither ornamental nor useful, but are destructive to gardens or pleasure-grounds, and consume the food that would keep half a dozen fowls. To compensate for the want of cocks at home, the hens may be sent, at certain seasons, to some one of approved breed in the neighbourhood.

TURKEY-OAK. See OAK.

TURK'S CAP. See MARTAGON.

TURMERIC,—botanically *Curcuma*. A genus of ornamental, tropical, perennial-rooted, annual-stemmed, herbaceous plants of the ginger tribe.

Upwards of twenty species have been introduced to the hothouses of Britain, principally from the Indian Continent and the Indian Archipelago. All are handsome in floriculture, and several are cultivated in the East for their uses in medicine and the arts. One, the broad-leaved, is commonly about 12 feet high; and another, the reclinate, is seldom more than about 6 inches high; and nearly all the rest have a height of between 1 foot and 5 feet. Most have either yellow, red, or red and yellow flowers; and the rest have either pink, crimson, brown, or white and violet flowers. A few, such as the zedoary, the zerumbet, the rubescent, and the rusty, love a soil of rich mould; but the others thrive best in sandy loam; and all, except the reclinate, are most readily propagated by division of the root.

The long-rooted turmeric, or zedoary-root turmeric, *Curcuma longa*, grows wild in the open sandy grounds of Malabar and Ceylon, and was introduced to Britain in 1759. Its root is tuberous, oblong, whitish, about as thick as a man's finger, and studded with the vestiges of defunct fleshy fibres; its leaves are subsessile on their sheath, palmated, broad, lanceolate, green above, and leathery below; its flower-stem rises from among the leaves, and is naked, and has commonly a height of about two feet; and its flowers grow in a loose, lateral, cylindrical, truncated spike, and bloom in April and May. The roots are imported into Britain, in casks and cases, from Bengal, China, and Ceylon. The best are firm, short, wrinkled, heavy, free from worm-eating, externally of an ash-colour, and internally of a deep orange-yellow. They break with a short close fracture, and are easily pulverized. Their odour is fragrant, and somewhat similar to that of camphor; and their taste is bitterish, aromatic, biting, and rather acrimonious. They contain, not only aromatic and bitter principles, but a very large proportion of starch and lignin; they yield by distillation with water a heavy, greenish, camphorated, essential oil; they surrender their active principles partly to water, and more completely to oil, ether, or alcohol; and, according to an analysis by John, they consist of 57 per cent. of lignin in combination with a substance which is soluble in potash but insoluble in alcohol, 11 of yellow resin, 12 of yellow extractive, 14 of gum, 1 of volatile oil, and 6 of water. Turmeric root possesses tonic and carminative properties; and is much used in the East for flatulent colic, nausea, difficult menstruation, and other diseases; and has a place in the Dublin pharmacopœia, and in the Materia Medica of various systems of medical botany, but is scarcely ever prescribed by British physicians. It was formerly in high esteem among farriers as a remedy for jaundice or yellows in horses; but it now possesses the reputation of only a common-rate or even inferior aromatic stimulant. It serves as an excellent chemical test of the presence of alkalies,—indicating their action by changing its colour to red brown; and, with the help of an alum mordaunt, it imparts a beautiful but perishable yellow dye to cotton, linen, and woollen fabrics. The Hindoos use it for dyeing both yellow and green; and combine it with lime juice to form the preparation with which they make the perpendicular mark on their foreheads.

The narrow-leaved turmeric, *Curcuma angustifolia*, was introduced to Britain from India in 1822. It has a height of about 3 feet; and carries yellow flowers in July. An alimentary substance, of a starchy nature, is prepared from its roots in Travancore, exactly similar to arrow-root, and so pure and good as to be scarcely distinguishable from the true arrow-root made from *Maranta arundinacea*. The population of the Malabar coast hold it in high estimation.

The zerumbet turmeric, *Curcuma zerumbet*, grows wild in many parts of Hindostan, and is extensively cultivated there for various purposes, and was introduced to Britain in 1807. It has a height of about 3 feet; and carries yellow flowers from April till August. Its roots are largely exposed to sale in the lower provinces of India; and are supposed to constitute a large proportion of the turmeric imported into Britain; and they commonly occur in small round pieces, about one-third of an inch thick, and from $1\frac{1}{2}$ to 2 inches in circumference.

The amada-ginger turmeric, *Curcuma amada*, was introduced to Britain from Bengal in 1819. It has commonly a height of about 2 feet; and carries red and yellow flowers from April till June. It is one of the kinds most frequently cultivated in the East; and has long had there a fully higher reputation than the long-rooted turmeric for medicinal purposes.

TURN. See Hydatid.

TURNERA. A diversified genus of exotic calyciflorous plants, constituting, with the genus piriqueta, the small natural order Turneriaceæ. This order is distinguished from Loaseæ, principally by the stamens being as numerous as the petals, and in their being inserted, not in the throat of the tube, but at the bottom of the calyx. The plants comprise both herbs and small shrubs; and have alternate exstipulate leaves and axillary yellow flowers; and are chiefly natives of tropical America.—About a dozen species of true turneras have been introduced to Britain; and about as many more are known. Two of the introduced species are hardy or half-hardy annuals, three are tender annuals, one is a hothouse evergreen perennial herb, and the rest are hothouse small evergreen shrubs.—One of the last, *Turnera ulmifolia*, was the earliest introduced; and may serve as a sufficient specimen of the whole. Its stem sends out branches on all sides throughout its whole length, and attains a height of from 3 to 10 feet; its branches are slender, and comparatively stiff, and well covered with foliage; its leaves are petiolate,

ovate-lanceolate, serrated, about 2½ inches long and 1½ inch broad, rough and lucid green above, and strongly veined and of a paler green below; its flowers sit close on the axils of the leaves, and have each five large, oval, bright-yellow petals, with twisted and joined claws, and bloom from June till September; and its fruit are short, tubular, one-celled, three-valved capsules, which open at the top and there discharge their seeds. A permanent and distinct variety, *T. u. angustifolia*, was introduced about the same time as the normal plant, and differs from it both in the form of the leaves, and in the size and tint of the flowers.

TURNHOOF. See ALEHOOF.

TURNIP. Any esculent-rooted variety of the genus brassica. See the articles BRASSICA, CABBAGE, COLE, RAPE, and KOHL-RABI. Swedish turnips and turnip-cabbages are varieties and subvarieties of *Brassica campestris napo-brassica;* common turnips are varieties and subvarieties of *Brassica rapa;* and hybrid turnips are the offspring of crosses between common turnips and other brassicas. The subvarieties of *Brassica campestris napo-brassica* are botanically classified into the normal, the common, and the ruta-baga, and were all brought into Britain from Sweden; and the varieties of *Brassica rapa* are botanically classified into the normal, the depressed, the oblong, and the oil-bearing, and all occur in a wild state in the corn-fields of England; but all the kinds of turnip in actual cultivation, whether Swedish, common, or hybrid, admit of several widely different classifications according to their shape and colour and other intrinsic properties, and according to their suitableness for the uses of the garden and the farm, and are more or less the result of powerfully modifying influences exerted by skill and culture upon the natural varieties.

All turnips are biennials, or have two seasons of growth,—one in which they develop leaves directly from the root-crown, and form their large bulbous stem, popularly called their root, and another in which they send up a long flower-stem, with leaves entirely different from those of the first season, and go through the process of flowering and seeding,—and all have blossoms and silicles exactly like those of cabbages and other brassicas; but many, at the same time, exhibit a tendency, in exciting or accelerating circumstances, to complete their cycle of development, or to rush to bloom in the first season, in the manner of annuals.—The root, or rather cauline bulb, of Swedish turnips is harder than that of common turnips,—and resists better the severities of winter,—possesses a higher proportion of nutritional principle and economical value,—and retains its juices and its nutritive properties till a more advanced period in spring; the stem is about one fourth or so shorter; and the leaves have a much darker colour, and less acridity, and more adaptation for food, and are so smooth as to present considerable resemblance to those of several of the expanded kinds of cabbage.—The root or cauline bulb of hybrid turnips, is internally yellow, and is yellow also on the portion of the surface beneath the ground,—and occasions all the class to be popularly called yellow turnips,—but is variously green, purple, dark purple, and other tints on the portion of the exterior above the ground, so as to occasion some varieties to be popularly designated by such names as green-top and purple-top,—and it possesses a hardness, a resistiveness, and a nutritiousness intermediate between that of swedes and that of common turnips, yet very different in different varieties; the leaves are quite or nearly the same as those of common turnips; and the habit and character are those of *Brassica campestris* and *Brassica napus*.—The root or cauline bulb of common turnips is internally white, and is white also in the portion of the surface beneath the ground,—and occasions all the class to be popularly called white turnips,—but is variously white, green, or red in the portion of the surface above the ground,—and is esteemed more palatable to the domesticated animals in the white-topped varieties than in the green or the red-topped ones,—and has, in some varieties, a spherical shape, popularly called globe-turnip,—in others, a depressed or flattened shape, often called Norfolk-turnip,—and in others, an elongated or subfusiform shape, popularly called tankard-turnip; the root-leaves, or leaves of the first season, are large, rough, jagged, and lightish green; the cauline-leaves, or those of the second season, are smooth and pointed; and the stem of ultimate growth, bearing the inflorescence and the seed, is from 2 to 6 feet high. Swedish turnips naturally bloom in June; and common turnips, in April. In the ordinary economy of the farm, Swedish turnips are sown earliest, yellow turnips next, and white turnips last.

Varieties of Swedish Turnip.—With the exception of the root or cauline bulb, which is large, fleshy, and subrotund, instead of small, hard, and fusiform, the specific characters of Swedish turnip and of turnip-rooted cabbage are the same as those of summer rape, *Brassica campestris oleifera;* and these exist chiefly in the leaves,—all of which are somewhat fleshy and have a dark green colour and a glaucous bloom,—the young ones on the root-crown lyrate and roughish,—and the cauline ones of the second season clasping or subcordate, oblong, and subpinnatifid. The root of ruta-baga or true Swedish turnip has a specific gravity of from 20 to 25 per cent. more than that of common turnip, and contains a much larger quantity, weight for weight, of saccharine matter; it bears the vicissitudes of the weather with such powerful hardiness, that a rotten individual of it is scarcely ever seen; and even when bitten by sheep or cattle, or broken by their feet, it so skins over and heals as to continue quite sound.

Though a crop of Swedish turnips looks much lighter on the ground than a crop of common turnips, it owes that appearance, in a considerable degree, to the circumstance of its root being less above the surface; and it largely compensates any real inferiority in bulk by decided superiority in at once weight, nutritiousness, hardiness, durability, and adaptation. Nor does it merely last much longer in spring without running up to flower; but also, when it arrives at that stage of growth, it preserves its nutritious properties far more largely from transmutation or injury; and even after ripening its seed, it retains in its pulp a very considerable portion of sweet and nutritive principles. The roots, too, are far better fitted for storing than those of common turnips; and, when drawn, and freed from tops and tails, and either put in water or secured under a light covering of straw, they continue for a comparatively long time unaltered. Swedish turnips also possess the advantage of being easily transplanted; so that beds of young ones can be advantageously used for filling blanks in the rows of either turnips, potatoes, or any similar crops. They require, however, a greater depth and power of soil than are requisite for common turnips; and succeed best upon loamy land of a nature suitable for wheat, and must be supplied even then with a generous dose of manure, in order to their yielding a full crop; for when grown either upon dry, hungry, gravelly soil with large supplies of manure, or upon good, deep, loamy soil with sparce supplies of manure, they are generally poor and feeble, and seldom produce roots of any considerable size.

The turnip cabbage or turnip-rooted cabbage is the normal *Brassica campestris napo-brassica*, and was erroneously supposed by some distinguished botanists of the last generation to be the source or original type of the cultivated Swedish turnips. It comprises several subvarieties; and, though similar in root to common or white or very bad Swedish turnips, it is very similar in leaf to some common kinds of borecole, and bears very distinct differential characters of both constitution and habit. Its roots grow almost wholly under the surface of the ground, and are naturally so very hardy as to resist all injury from even the severest winters; but they are by no means so valuable as those of even the worst kind of swedes. It is cultivated in the northern parts of Continental Europe, and is much lauded by some Continental writers; but it will probably be superseded in all places by some one or other of the hardiest or otherwise best kinds of ruta-baga, when the latter shall come to be duly known.

The white Swedish turnip is the common variety of *Brassica campestris napo-brassica*, and occupies an intermediate station between the turnip cabbage and the coloured or true Swedish turnip. Its roots are irregularly shaped, and have many branches or fangs; and they are interiorly white-fleshed, and exteriorly white below the surface of the ground, and greenish above. It is decidedly inferior to even the worst kinds of true Swedish turnip; and has undergone little or no improvement from hybridizing or special culture; and is at present an object of no interest to British cultivators; and, when it occasionally appears among true Swedish turnips, is considered as either a degenerated plant or the offspring of bad seed. It found its way into a considerable number of farms in the years immediately following the period when the true Swedish turnip first became known; and it, in consequence, greatly damaged the reputation of that plant, and retarded its rising into general confidence.

The coloured or true Swedish turnip is the ruta-baga variety of *Brassica campestris napo-brassica;* and may readily be distinguished from the other varieties by the comparative largeness and rotundity of its root, by the yellowish colour of the root's flesh, and by the yellowishness of the root's exterior in the part below the ground, and the higher colouredness, either dull red or purple or dull green or some similar tint, of the upper part. The subvarieties of it in cultivation are not nearly so numerous as those of the common turnip,—partly because it has been much less subjected to experiment, and partly on account of its inferior plasticity and sportiveness of constitution; yet a few improved ones have been obtained and established,—some by processes of hybridizing, and others by careful, repeated, judicious selection of plants for the raising of seed-stock.

Skirving's new improved purple-topped swede, was introduced by Mr. William Skirving, of Walton Nursery, near Liverpool; and was pronounced by him to possess all the good qualities of a turnip, as compared with all the known varieties which he was able to collect both in Britain and on the Continent, and to yield a greater weight per acre of sound nutritive bulb than any other variety, and to be also hardier and longer-keeping. Its leaves appear to partake considerably of the character of those of the common turnips, being less smooth and more serrated at the edges than those of the genuine Swedish turnip, and deficient in that glaucous bloom which distinguishes them; so that he may be supposed to have attained the size by hybridizing with some of the larger varieties of yellow turnips.

Ballantyne's new improved purple-topped swede, takes its name from its original introducer, Mr. Ballantyne, nursery and seedsman, Dalkeith. It is, for symmetry and shape, equality of size, and the uniform deep purple colour of its top, unsurpassed by any other variety; yet is more remarkable for the combination of these qualities and for the smallness of its neck, than for the largeness of its bulb.

Scott's prize purple-topped swede, was introduced by Mr. Scott of Southend, near Tranent, in East Lothian. It is ox-heart shaped, purple above ground, and yellow-fleshed, with a small top.

Laing's new purple-topped swede is a decidedly distinct variety. Its leaves are somewhat like those of a lettuce; and are so inserted in the top of the root as to give it much the appearance of a pine-apple. It grows to a good size, keeps well, and bears a very high character among the agriculturists of Berwickshire and Northumberland, where it is extensively cultivated. The crop when in full leaf has a most beautiful appearance.

The green-topped yellow swede has been longer known than the purple-topped, and, since the introduction of the latter, has had less attention bestowed upon it by cultivators, and has fallen somewhat in their estimation; but where the same care is taken in selecting the roots grown for seed, it may be considered as equal in merit to the purple-topped.—Scott's prize green-topped yellow swede, is an improved variety of it, and is in no way inferior to the purple-topped.

Hillyard's Thorpeland swede, has the appearance of a true Swedish turnip, and closely resembles some which were recently raised from seed procured from the Botanic Garden at Upsal. It is said to be more nutritive, bulk for bulk, than some of the largest varieties; but its dwarfish size, and the impossibility of raising any great weight of food per acre from it, must, notwithstanding its other merits, be a great obstacle to its making its way among the larger sorts which now invite the attention of cultivators.

Cox's new improved swede, may be considered as intermediate in colour between the purple and the green-topped sorts. Its roots often attain a large size, but are rather irregular, and of a somewhat coarse-like quality. "Such subvarieties," remarks Mr. Lawson, in reference to Cox's, "are frequently of short duration, being liable to degenerate when the careful selection of the roots to be grown for seed is not attended to; and they often only retain the name for such time as their seed-stalks are grown by the parties with whom they originated; and it occasionally happens, that stocks procured in different parts by the same means, and known under different names, may yet be the same in other respects."

Varieties of Hybrid Turnip.—Hybrid varieties of turnip are obtained either by selecting and cultivating seed-stocks of plants which appear to have undergone natural cross-impregnation, through the agency of insects or the wind, or by carefully conducting a process of artificial cross-impregnation in the manner practised in gardens for obtaining choice new varieties of the rare kinds of flowering plants, or by so combining the two methods as to intermix turnips of different breeds through a series of bloomings in order to expose them to natural cross-impregnation, and then to select from each of the series of crops only such plants for seed-stocks as exhibit improvement and are similar in character. One of the most celebrated and useful and at the same time variable of all the hybrids—the well-known and generally-esteemed Dale's hybrid, raised by Mr. Robert Dale, of Libberton, West Mains, near Edinburgh—was procured by a complexity of method which may suggest valuable hints for guiding the efforts of intelligent agriculturists in search of further improvements. The basis of it was a new hybrid, grown by a gentleman in Berwickshire, and supposed to have been obtained by an indefatigable veteran improver of turnips in Aberdeenshire. Mr. Dale sowed a few ounces of the seed of this hybrid, and found the produce to resemble Swedish turnips in shape, but to be destitute of most of their superior intrinsic properties. He therefore picked out such roots as had most of the yellow appearance, and planted them along with some of the best true swedes he could find; this he continued to do for four successive years; and he afterwards selected the best roots of the complicatedly impregnated produce for raising seeds till all the fine properties of the variety which now bears his name were obtained and became established. "The manner in which this variety was obtained," remarks the narrator of his proceedings, "was not according to the nice rules which horticulturists would have recommended to be adopted; because, as the hybrids were always planted along with the Swedish for producing seed, and the seed collected promiscuously, that part of the seed which was produced from the Swedish would be much more nearly allied to that variety than the seed of the hybrids. But in this as in many other instances of improving plants, the point is often attained more from accidental causes than from the adoption of the rules laid down by scientific cultivators. And, although all the hybrids may not stand in the same relation to the primitive root, the circumstance of the raising the seed being now performed solely by the hybrids themselves, without the assistance as formerly of the Swedish, will always have the tendency to assist in modifying and correcting any irregularity that may exist." Every hybrid obtained in any such way, in fact, is rather a collection of many closely related and intimately similar subvarieties than one really homogeneous or strictly individual variety; and yet, throughout every crop and in all ordinary circumstances, it possesses abundantly sufficient uniformity for all practical purposes both of culture and of application. The several hybrids in most estimation also differ more or less widely from one another in some or most of their best properties; while all, at the same time, when regarded in the aggregate, so combine the characters of Swedish turnips and of common turnips as to occupy a somewhat equable intermediate station be-

tween these two great groups. All the kinds we shall enumerate, except such as we shall designate exclusively garden turnips, are suitable for cultivation in the field.

The Altringham yellow turnip is smaller than most of the approved hybrids, and on that account is more particularly suited for garden culture; yet it is also in good repute in some quarters as a field turnip. It is recommended for its fine globular shape, and the superior solidity of its flesh. It has a light greenish top, very small neck, and tap root.

The Aberdeenshire sugar yellow turnip is very hardy; and buries itself considerably in the ground; and is highly nutritious, and one of the most approved of the lately introduced varieties.

The Border imperial purple-topped yellow turnip was introduced by Mr. R. Hogg, nursery and seedsman, of Dunse, in Berwickshire; and is described as follows by Mr. Hogg himself:—"This turnip possesses all the qualities of the Swedish, with the advantage of being a much freer grower. It succeeds well on every variety of turnip soil, produces a larger crop than the white globe, is a good feeder, and stands the winter better than any of the common yellows. It is in full perfection for using in February, and continues for as long a period as the swedes; and should the latter fail, the Border imperial being sown as late as the month of June, will yield a crop equal if not superior to what might have been expected from the swedes had they succeeded."

The green-topped bullock yellow turnip attains a medium size. Its shape is globular, or somewhat flattened with a very small tap-root. It is an old variety; and is held in deserved estimation.

The purple-topped bullock yellow turnip differs from the preceding chiefly in the colour of the top,—the size, shape, and quality of the roots being pretty nearly the same. It is also highly esteemed; and is considered by some to come nearest to the swedes in hardiness and solidity of texture.

Skirving's improved purple-topped bullock yellow turnip is an improved variety of the preceding; and obtained for its introducer, Mr. William Skirving, of Liverpool, the medal of the Highland Society of Scotland. It has been generally grown for a number of years by the first agriculturists in Lancashire and the north-western counties.

The green-topped and the purple-topped yellow Scotch turnips differ but little in any of their essential properties from the common green-topped and purple-topped bullock yellows. The roots are flatter and grow more in the ground.

The ox-heart yellow is an excellent turnip. Although it comes early to maturity, and attains a considerable size, it is by no means deficient in hardiness.

The yellow globe is a superior turnip, both for field and for garden culture. Its roots are of a medium size, globular, and always nearly under the surface of the ground; its top is greenish; and its leaves rather small and spreading.

The yellow stone turnip differs from the preceding in growing more out of the ground, and having a greener top. In other respects it is nearly similar; and as a garden turnip, it is held in high esteem.

The brown-topped tankard yellow turnip, has a bright yellow root, of a somewhat irregular, long, or tankard shape, with a purple or brownish top; and it is of great repute in Aberdeenshire. A sub-variety of it, with not so very long a shape, is preferred by some growers. Both are excellent turnips.

The green-topped tankard yellow turnip differs from the preceding chiefly in the colour of the top; and of this there is also a sub-variety of a flatter shape.

The large Lawrencekirk yellow tankard turnip, introduced by Mr. Robert Scott of Lawrencekirk, resembles Dale's hybrid in many particulars; and, like it, grows a good deal out of the ground; but is distinguished by its more oblong and more uniformly shaped roots. Like Dale's hybrid, it arrives early at maturity; but it is generally considered rather less hardy, although it yields an equally bulky crop.

Dale's hybrid turnip is distinguished chiefly by its foliage being strong and luxuriant, and its roots of a large size, oblong shape, and of a lightish yellow colour, with light green top, small neck, and tap-root. The form of the root, however, although generally oblong, is rather apt to vary, being sometimes almost globular; but its more material characteristics of large size and luxuriance of growth are always the same. Compared with any other of the yellow field-sorts, it is found to arrive sooner at maturity, and consequently may be sown at a later period of the season; while at the same time, it is equally hardy, or, at least, has been found sufficiently so to withstand the severest winters which have occurred since its introduction. It might seem, from the manner in which Mr. Dale obtained it, or at least from that in which he brought it to perfection, to be rather a variety of swede than a true hybrid; but it distinctly exhibits its intimate connexion with the common turnip, partly by its root having considerable affinity in both form and texture, and chiefly by its leaves being rough and of a vivid green colour and destitute of the swedish glaucousness.

The new purple-top hybrid turnip, raised by Grant Duff, Esq., of Eden, Banffshire, seems more nearly related to the swede than even Dale's hybrid, but has also the rough vivid green root-foliage which characterises the common turnip. Its root has a slightly oblong shape; and is light yellow or almost white on the lower part of the surface, and greenish purple on the top; and is

remarkably firm in texture, and keeps comparatively well and long in spring.

Gordon's yellow turnip is a very superior variety, and derives its name from Mr. Gordon, of Orrock, the father of turnip husbandry, in Aberdeenshire. It is of rather oblong shape, and of deep green colour on the top, generally very slightly tinged with red. It is very nearly allied to Dale's hybrid, being a cross between the Aberdeenshire bullock-yellow and the swede. Sir F. A. Mackenzie, Bart., a very accurate experimentalist, grew a considerable number of the most approved kinds of turnips on his farm, at Conan Mains, near Dingwall, with the view of selecting such as might be found best suited to the soil and climate of Ross-shire; and the result of his experiments was, that of swedes, Skirving's is decidedly the best,—of the hybrids, Gordon's yellow is the best,—and of the white kinds, Scott's purple-topped hybrid, and the old white globe are the best.

Hood's new large yellow turnip is a very superior, large, globular-shaped, hardy turnip, remarkably perfect in symmetry, with rather a lightish green top; and was introduced by Charles Hood, Esq., an eminent farmer, at Inverbrora, in Sutherlandshire.

The Pollexfen yellow turnip derives its name from its introducer, Thomas Pollexfen, Esq., of Cairston,—who had long practice and a peculiar method both in selecting and transplanting the bulbs, and in stocking and preserving the seed. The insular situation of Orkney, too, although in latitude 59° north, renders its climate less exposed to the extremes of heat and cold than in more continental situations farther south, the winters being mild, and the frost so gentle, that the ice is seldom sufficiently strong to sustain the weight of a man; and it is on that account particularly favourable to the growth of turnips, —so that turnip-seed grown in Orkney is highly prized by the Scotch farmers. The Pollexfen yellow is a green-topped turnip of a large size, rather flattish in shape, and very smooth and thin in the skin. Its flesh is firm and nutritious, being slightly impregnated with the green-topped swedish. It is adapted for winter and spring feeding, and is not liable to injury from frost. This turnip obtained the prize at the meeting of the Highland and Agricultural Society of Scotland, held at Inverness, in 1836; and was highly commended in the report.

The Cambridgeshire long tankard yellow turnip, or pudding swede, is cultivated somewhat extensively in Cambridgeshire and Suffolk, but is scarcely known in some large districts of the kingdom. Its root generally grows more than half under ground; and has a lightish yellow colour in the lower parts and a green colour on the top; and is much more elongated in form than that of most other kinds of even tankard turnip; and takes its name of pudding swede, rather from the hardness of its texture, than from any other near resemblance to any true swede.

The purple-topped tankard yellow turnip was formerly cultivated in some districts of England, but has for some time been passing toward total neglect. It is a coarse inferior variety, and does not yield near so large a crop as some of the best kinds, whether tankard or sub-rotund. Its root has a long and somewhat irregular form, and is bright yellow in the lower parts and purple on the top.

Jones' yellow turnip originated many years ago, in the neighbourhood of Stirling, and soon obtained extensive favour throughout the surrounding country. Its root has a considerable resemblance to that of the Altringham yellow, but attains a larger size, and has a yellower hue in both skin and flesh.

The yellow Malta turnip, or Maltese golden turnip, is suited exclusively to garden culture; and is one of the most esteemed of all the hybrids for summer and autumn crops; but is too susceptible of injury from frost to be proper for a late crop. Its leaves are very small; and its root or cauline bulb is also very small, and is slightly flattened above, and much hollowed on the under side, and has a very smooth skin and a bright orange-yellow colour; and its tap-root, as also its neck, is remarkably small.

The Preston or Liverpool yellow turnip is also suited exclusively to garden culture, and for summer and early autumn crops. It considerably resembles the yellow Malta turnip, but attains a larger size, and has stronger foliage, and is less hollowed on the under side of its root.

The Dutch yellow turnip is also suited exclusively to garden culture, and for summer and early autumn crops. It has a superior flavour, and is much esteemed. Its root is small and globular; and has all over a pale yellow colour; but often—especially when grown in full exposure to sun and weather—is very slightly tinged with green on the top.

The large long garden yellow turnip is a hardy and somewhat superior variety, exclusively suited to garden culture, and pretty extensively grown in some parts of Continental Europe, but not much known in Britain. Its root grows about three-fourths under ground, and has a deep yellow colour in all the lower parts and a greenish colour on the top.

The small long yellow turnip is an excellently flavoured variety, suited exclusively to garden culture; and is somewhat largely grown in Holland, France, and other parts of the Continent; and was formerly imported in a grown state for the supply of the London vegetable market; but is little known among the gardeners of Britain. It thrives best on sandy soils, and buries itself so entirely in them, as to enjoy comparatively good natural protection from frost. Its leaves are very small and spreading; and its root is small and fusiform, and terminates abruptly at the

point, and has a light yellow colour, and in general grows entirely under ground.

Varieties of Common Turnip.—White turnips, in a general view, are suitable for use only in the early and middle parts of the year, and are most profitable only when so raised as to be all consumed before any of the swedes or of the firmest and largest hybrids become fit for use; for when they grow beyond a certain size, they lose a considerable proportion of their nutritious principles,—or when allowed to remain on the ground after they attain full bulk, previous to the commencement of the autumn or winter frosts, they become soft, spongy, unpalatable, and comparatively worthless. The depressed and the tankard varieties, in particular, are totally unsuitable for winter feeding,—the former, on account of their retaining moisture in a concavity on their upper surface, so as to be easily rotted and destroyed after the season of heat and of high evaporation has passed away,—and the latter, not so much on account of the softness of their texture, as because they stand mostly above the ground, and are therefore very much exposed to the action of frost. The good or approved varieties of common turnip are exceedingly numerous, and present a great diversity of both external and internal character; and, in some instances, are so near akin to some of the yellow hybrids, as to be distinguishable mainly by the whiteness of the skin and flesh. All those we shall enumerate, except such as we shall state to be suitable only for the garden, are proper for field cultivation.

The white globe turnip comprises a common or normal variety and a considerable number of distinct and rather widely different subvarieties. The root of all its kinds has a globular form, a small neck, a small tap, a smooth skin, and perfectly white skin and flesh; but that of some kinds has been considerably altered from the normal state in consequence of the special care and attention of cultivators in selecting their seed-stocks; and that of any one kind is often not a little affected by the nature and condition of the soil in which it is grown. Thus globes of any kind, and particularly the common white globes, when grown on a very superior rich soil, may be said to be forced beyond their natural size, so as to acquire somewhat of a monstrous or overgrown appearance, and to lose in a great measure their natural symmetry of shape.

The Pomeranian globe turnip was introduced not many years ago from Pomerania, and may be considered the most perfect globe turnip in shape, as well as the most regular or uniform grower. Its skin is smooth and white, and has a somewhat shining or transparent-like appearance; and its leaves are smoothish, and of a dark green colour, with whitish nerves.

The green globe has a fine globular shape, with a small neck and small tap-root; and is very white beneath, and green above the surface of the ground; and is of medium size, hardy, and firm of texture; yet is scarcely so firm as the green round turnip, although it arrives rather earlier at maturity.

The stone globe is considered to be the hardiest of all the entire white globe turnips; and it grows naturally deeper in the soil than the others, and has stronger and darker green foliage.

The red globe turnip is medium-sized, globularly shaped, and firm in texture. This is an old and in some districts a pretty extensively cultivated variety. It is medium early, and generally allowed to be particularly well suited for light soils and exposed elevated situations.

The white round turnip is known in Lincoln by the name of spring white. It is the largest of the round turnips, and, at the same time, the softest and most irregular in shape. It is generally hollowed towards the neck, and, in consequence, is apt to be injured by retaining moisture, which renders it unfit for using, except in the beginning of the winter season. All the round or depressed turnips have a peculiar flattish shape, rather hollow towards their neck, as also on their under side; and when grown to a large size, they become more or less of an irregular round or somewhat cornered shape.

The green-topped round turnip possesses these characters in a less degree than the white round, and is generally of a pretty regular circular shape, flattened but not much hollowed on the upper and the under surfaces, the former of which is of a green colour, and the latter white. It is the hardiest of the round turnips.

The red round turnip is inferior in size to the two former, but rather firmer in texture, and more regular in shape. It should also be used in the early part of the season.

The white tankard turnip has its roots more than half out of the ground, and oblong or tankard-shaped, but often bent or crooked. It is the largest of the tankards, but is also softer in texture than either the red or the green. Its leaves are large and luxuriant. It is the earliest in maturing of any; but will not stand the frost.

The green tankard turnip also has its roots more than half above the ground; and they are of a greenish colour, except on the under surface, which is white.

The red tankard turnip, in size, form, and texture, may be considered as occupying an intermediate place between the white and the green tankards. It is of a bright red colour on the upper surface, and white on the under.

The Lawton hybrid turnip was raised by James Wright, Esq., of Lawton, near Perth; and may be considered as bearing the same relation to the Swede as Dale's hybrid. Its leaves are darkish green, rather small and smoothish; and its roots are roundish or somewhat heart-shaped, being often tapered on the under side, white below, and green above the surface of the ground; and they are hardy, and possessed of more solidity and firmness of texture than most white sorts.

Scott's improved purple-topped hybrid turnip obtained the prize of the Highland Society of Scotland, at the meeting at Glasgow in 1839, and owes its origin to the exertions of Mr. Scott, of Southend, near Tranent. For a white-fleshed turnip, it is remarkably solid, and attains a great size; and it is decidedly the best in point of size, symmetry of shape, uniformity of growth, and quality of flesh, of very many varieties of white turnips which have been simultaneously tested in model-plots by some distinguished experimentalists.

The Lewisham green-topped, ox-heart turnip is an excellent variety, grown in some of the southern districts of England and in Scotland; and it acquired its name from having been introduced by Messrs. Willmot and Co., of Lewisham.

The autumn stubble or six weeks turnip has its roots much above ground, rather large, of an irregular, globular shape, or in form between the white globe and white round, and rather soft. This sort arrives sooner at maturity than any of the others, the tankard turnips perhaps excepted; and from its natural softness of texture, should always be sown late, and used before the severe frosts set in. Its names are descriptive of its forwardness; and it is suited for sowing, in early situations, in autumn, after the corn crop has been removed; and is also valuable for making up blanks in turnip fields, where the first sowing may have partly failed.

The white Dutch turnip is suitable chiefly for the garden, and answers there as an excellent early variety; and it has been recommended also for a field crop when late sowing is necessary, but is not by any means so well adapted for that purpose as the tankard varieties, or the autumn-stubble variety. Its root is of excellent quality when young; but becomes soft, spongy, ill-flavoured, irregularly circular, and much flattened when full-grown.

The red Dutch or early garden turnip is also suitable chiefly for the garden. It is an excellent variety, but is little known in Britain. Its foliage is smaller and of a darker colour than that of the white Dutch turnip; and its root has a very similar shape to the root of that variety, but has a bright red colour in the part of the surface which is above ground.

The white garden turnip, or early stone turnip, is suited exclusively to garden culture; and is one of the best known and most generally cultivated of the garden turnips. It has stronger foliage and a rounder and firmer root than the white Dutch turnip, but is not so well adapted for early spring sowing, and more apt to run to seed; and it acquired its epithet of early, not from any special adaptation which it has for early sowing, but from the circumstance of its arriving soon at maturity when sown at a later period of the season. An improved and carefully selected subvariety of it is cultivated in some parts of England, under the name of the mouse-tail turnip.

The small long white turnip is cultivated on the Continent under the same circumstances as the small long yellow turnip; and it resembles that variety both in the character of the foliage, and in the form and habit of the root, and differs from it principally in the colour of the root.

The Maltese long white turnip, or the small very long turnip, has a general resemblance to the preceding; but the upper part of its root generally grows above the ground, and has a greenish colour,—and the lower part is longer, and tapers more gradually toward the point.

The round black turnip claims connexion with the common or white turnips principally for the whiteness of its flesh, and for its total want of affinity to either the swedes or the hybrids; and, in common with the three other kinds which we shall name in this paragraph, it has a hottish and somewhat radish-like taste, and is suited exclusively to garden culture, and possesses much repute in some parts of the Continent for its sapid and antiscorbutic properties; but is not much known in Britain. Its leaves are few, small, and rather smooth; and its roots grow almost wholly under ground, and have a black-coloured and very rough skin, and are of an irregular roundish form, and often divide or fork or ramify into thick fangs at their lower extremity. —The round brown turnip differs little from the preceding except in the dull brown colour of its roots.—The long black turnip differs from the round black principally in the long carrot-like shape of its roots.—The long brown turnip bears the same relation to the round brown turnip which the long black does to the round black.

The Teltau turnip, or small Berlin turnip, is the smallest of all the known varieties of turnip and of course is suited exclusively to garden culture. Its root is oblong or carrot-shaped, about three inches long, seldom more than an inch in diameter at the thickest part, of a dull transparent whitish colour, or very light lead-colour, and has a peculiar and slightly hot taste.

The History of Turnip Cultivation.—The uses of both the roots and the tops of turnips were as well known to the ancient Romans as to any modern European farmers; and the winter-feeding of cattle with the roots, though a not very old improvement in British husbandry, and justly regarded as one of the most important in modern times, was practised among the ancient Gauls. "The Roman authors," says Pliny, "have treated of *rapa* in only a cursory way; the Greeks more particularly, but as a plant to be cultivated in gardens. If a just order were observed, it should be mentioned immediately after corn, at least after the bean; for no other plant is more excellent or useful, or so well adapted for food to all sorts of animals. The seed, particularly if boiled in water, is proper food for all kinds of village fowls; the leaves serve to fatten quadru-

peds; and in their season, the tender shoots are as agreeable to man as those of any other plant. The turnip also, when dried and preserved, is better than when green; for it becomes hard, and, when kept in earth, it remains good almost to the season of the next crop, and therefore is a constant food. The people on the other side of the Po reckon this plant the third in goodness, or inferior only to grapes and corn. It is dressed in a variety of ways for use at our tables, and when mixed with mustard, is preserved for culinary purposes throughout the year. Besides its natural colour, it may be stained purple and five other colours; and it admits of being more conveniently and variously dressed in this way than any other culinary plant." "Both *rapa* and *napus*," says Columella, "may properly be classed with pulse; for both are used as food by country people. The *rapa*, however, is the more useful of the two; for it yields a greater amount of produce and serves for food, not only to men, but also to oxen, especially in Gaul, where it is used for feeding cattle in winter."

At what time the field cultivation of turnips was begun in Britain is not known; but it seems to have been, if not introduced, at least either reintroduced or powerfully stimulated, from Flanders, and to have taken special root in Norfolk, about two centuries ago; and it possibly was retained in Flanders, throughout all the middle ages, as an heirloom from the ancient Gauls. Worlidge, in his Mystery of Husbandry, printed in 1669-81, says, "In Holland, they slice their turnips with the tops, and rape-seed cakes and grains, &c., and therewith make mashes for the cows, and give it them warm, which the cows eat like hogs." And he complains of the very great neglect of all similar uses of turnips in the farm-economy of England, and remarks, "Although turnips be usually nourished in gardens, and be properly a garden-plant, yet are they, to the very great advantage of the husbandman, sown in his fields in several places in England, not only for culinary uses, as about London and other great cities, but also for the food of cattle." The field cultivation of turnips in Norfolk is commonly said to have been introduced by Lord Townshend, but seems really to have existed before his period; and though long confined to only a very few individuals, it afterwards spread into considerably extensive favour, and was at length greatly improved by incorporation with the row method of sowing according to the system of Tull. The earliest kinds of turnips grown were the oldest and worst varieties of the round or depressed; and these, in common with all the newer sorts of the same group, continue to the present day to be often popularly called Norfolk turnips,—though the kinds now cultivated in Norfolk are equal in diversity and value to at least the average of the kinds grown in the best of the other agricultural districts of the kingdom. "The usual mode of sowing turnips both in Flanders and in Norfolk," said the Rev. Mr. Rham, about ten years ago, "was broadcast; and as the labourers in both countries became very expert in hoeing them out at regular distances, this mode was long preferred. In fact, the cultivation of turnips in rows is scarcely practised at all in Flanders; and, notwithstanding its evident superiority in respect to quantity of produce and economy of labour, it cannot be said to be yet universally adopted in Norfolk,—so slowly does every agricultural improvement spread among the great mass of farmers."

The cultivation of turnips in drills, though introduced by Tull, was early and long known, and in some districts is even yet known, under the name of the Northumberland system. Tull gave his favourite horse-hoeing operations to turnips, not as in modern practice chiefly before sowing, but mostly or wholly after sowing; and he appears to have used principally intervals of three feet. About the year 1745, Mr. Craik of Arbigland, in Dumfries-shire, became the earliest cultivator of drilled turnips on the Scottish borders; about ten years later, Philip Howard, Esq., of Corby, became the earliest cultivator of them in Cumberland, and grew them for some time at intervals of four feet, and afterwards at intervals of two feet; and nearly at the same time, Mr. Pringle, near Coldstream, in Berwickshire, cultivated turnips in drills, at $3\frac{1}{2}$ feet distance, and likewise drilled his grain crops,—following in both cases the general principles of Tull. "At this time," says the General Report of Scotland, "William Dawson, Esq., of Graden, an intelligent and successful farmer in Roxburghshire, after some residence in the county of Norfolk, where he had attentively studied the system of alternate husbandry, adopted the practice of Mr. Pringle, in regard to the cultivation of turnips, in preference to the mode which he had seen practised in that celebrated county. Mr. Dawson began the drilled turnip husbandry in 1764, on an extensive scale, growing nearly 100 acres yearly. He ultimately fixed upon 30 inches as the best interval for the purpose, after repeated trials both of broader and narrower; and his practice has been universally followed in all the border counties."

The turnip husbandry greatly aided the transition from the barbarous agricultural usages of the middle ages to the enlightened ones of the present day; and is now well known to every good farmer to be the sheet anchor or *sine qua non* of the modern alternate and convertible husbandry. See the article ROTATION OF CROPS. "The introduction of turnips into the husbandry of Britain," remarks Brown in his Treatise on Rural Affairs, "occasioned one of those revolutions in the rural art which are constantly occurring among husbandmen. Before the introduction of this root, it was impossible to cultivate light soils successfully, or to devise suitable rotations for cropping them with advantage. It was likewise a difficult task to support live-stock

through the winter and spring months; and the practice of feeding cattle and sheep for market, during these inclement seasons, was hardly ever thought of or attempted, unless in a few instances, where a full stock of hay was provided. The benefits, therefore, which are derived from turnip husbandry are manifold and of great magnitude. Light soils are now cultivated with facility and profit, by which abundance of food is provided for man and beast; the earth is turned to the uses for which it is physically calculated; and, by being suitably cleaned and fertilized by this preparatory crop, a bed is provided for grass-seeds, in which they prosper with greater vigour than after any other mode of preparation."

The Swedish turnip, too, came into use at a fine juncture for completing the great advantages which the field cultivation of the common turnip had begun to confer. It was introduced from Germany to England about the middle of last century, and from England to Scotland in 1766; so that it did not come in till a period of the new husbandry when its value could be appreciated, and did not lag so long behind as to let the defective power of the common turnip for spring-feeding and late winter-feeding become hopelessly discouraging. It soon proved itself of extraordinary service to intelligent and enterprising farmers who had adopted the alternate husbandry, by enabling them with tolerable certainty to fill the wide and critical gap in the supply of food for stock in late winter and early spring, or to keep their stock in full numbers and in pretty good condition during the trying season between the exhaustion of the common turnip and the commencement of summer feeding,—so that they were no longer under the severe alternative of being obliged either to force off their feeding stock to market at the exhaustion of the turnip, bring what price they might, or to carry them on at a vast expense by means of oil-cake, hay, bean-meal, and other costly articles of food; and the Swedish turnip, at the same time, offered a ready source, which eventually came to be well understood and appreciated, of forming those valuable hybrids between it and the common turnip which now occupy so large and advantageous a place in the economy of a great proportion of extensive farms.

But while the turnip-husbandry rapidly effected a revolution, and has long been achieving wonders, in some parts of Britain, it has been dismally neglected, or even continues to be regarded with indifference or dislike in others. Persons who live in districts where the crop is considered so essential that the operations of a farm could not be conducted to profit without it, will scarcely believe that in many parts of the kingdom, even at this date, turnips are grown only by amateurs, or those who are supposed to be making experiments; whilst the expense is considered to be too great for tenants to encounter who pay high rents for their land. The fact is, that many farmers, looking only to present consequences, begrudge the manure required for this crop, and rather apply it to stimulate a crop of corn which they can turn into money at the nearest market,—forgetting that the green crop is not only the procurer of future ones, but that the root is available for fattening sheep and cattle, or, if applied to the store stock, of keeping them not only in good condition, but in increased numbers. In Ireland, too, throughout the greater part of which the turnip husbandry continues still to be unappreciated, absurd and inveterate prejudices are entertained against it in favour of the wretched system of a continual growing of mere corn and potatoes. "Even in the vicinity of bogs and mountains, where the means of raising ashes, in which turnips delight as a pabulum, are on the spot," remarks Martin Doyle, "they are never grown by a mere practical husbandman, though their culture does not necessarily interfere with the raising of the more essentially necessary potato crop. Whence is this? Potatoes, wherever manure can be raised, are in the first case considered more profitable, from the demand for human food in countries where the consumption of grain is so inconsiderable; secondly, from the mistaken notion that potatoes are more remunerative as food for cattle; thirdly, from the conviction that, however extensively sown, they would be stolen as a dainty for the human palate. The first and second objections require no discussion, and the third is of no weight. The petty depredations of women and of urchins cease when the novelty of the crop wears off. The same objection once operated against the culture of turnips, and of beans too, in Great Britain. In parts of Ireland, at this moment, where beans are systematically and abundantly cultivated, the same complaint was made by the farmer on their first introduction, and similar difficulty would be at first experienced in those places where beans, as a field crop, are now utterly unknown, and the purely mental association of boiled garden beans and bacon might lead to the mistake that raw tick beans must also supply excellent and delicate fare. Let turnips once become common in culture, and they will not be improperly meddled with, even in the most dishonest localities. What has not turnip culture effected for England? What has not the same system wrought in Scotland?"

The Preparation of the Land for Turnips.—All comparatively dry soils, from the poorest sand and gravel up to the richest free loams, are more or less suitable for common turnips; while either light soils on a retentive bottom or clayey soils upon any sort of bottom whatever are apt to make them fail, especially in dry seasons; and soils of a comparatively heavy character, or those near akin to the best wheat and bean soils, are the most suitable for Swedish turnips. Yet almost all kinds of soils which are capable of

thorough tillage have, with more or less success, been cropped with even the inferior varieties of white turnip; and all may, with due management, particularly under systems of efficient subsoil-draining, and skilful tillage and manuring and after-culture, be more or less profitably cropped with some of the varieties of hybrids.

Turnips were long cultivated on land which had already borne a crop which was reaped early in summer, and on bare fallow which had been worked and cleared at a sufficiently early period in the season to allow the turnip crop to be sown and grown and removed before the time for sowing winter corn; but all turnips raised in this way, and technically called addish or stubble turnips, yield a comparatively small bulk of produce, and serve very inferior purposes in the course of a rotation, and offer none of the important advantages which are enjoyed in the method of feeding off with sheep, and perform a somewhat inefficient part in connexion with both the general working of the soil and the comprehensive economizing of manure. Turnips, as now cultivated, generally succeed a crop of wheat. In some cases, indeed, on very poor soils, the clover leys are broken up for turnips; and in others, a crop of winter tares, either mown or depastured, is taken off between the wheat crop and the ploughing for turnips;—but as a regular system, the former cannot be pursued, for the frequent recurrence of the turnip and the clover crops would operate injuriously, and defeat the object of the cultivator,—and the latter is applicable only to soils which are quite free from root-weeds, and of a superior staple, or in a very high state of cultivation.

As soon as the corn crop is secured, and the stock has passed over the stubble, the land should be ploughed, in order to subject the soil to the ameliorating influence of the frosts of winter. In all cases the plough should pass below the couch-grass, which is usually most abundant in inferior soils,—but seldom below the mould. In ordinary cases, nothing is more necessary than to prevent the water from standing in any part during the winter; and where the land is intended for swedes, an effort should be made to have it partly or entirely cleared of weeds before the winter. When the land is free from weeds, the cross-ploughing may be begun as soon as the dryness will admit of it; and, in general, it may take place in February with advantage, inasmuch as it exposes a new and more extensive surface to the action of the frosts which generally succeed. If the land be allowed to remain a month or two longer, it may be advantageously crossed with Finlayson's harrow. Where the couch-grass, however, is abundant, it is positively injurious to cross-plough early, as the operation breaks the roots and renders the cleaning of the land afterwards tedious and difficult; and, in every such case, the operation should be delayed until the soil is dry; or even if it should be delayed till the latter end of April, or the beginning of May, more will be effected by one ploughing in this case than by two under different circumstances. When the dryness admits of it, usually in two or three days, the land should be harrowed across, first with the patent or hinge harrows, and subsequently with the loose harrows, which separate the rubbish more effectually from the soil; and then the weeds should be raked off,—an operation which is generally performed by women. As soon as the couch-roots, &c., are cleared off, either by carting into large heaps or burning into small ones, the land may be dragged with Finlayson's grubber or any approved drag, and the same course followed so long as any roots remain. When the roots and hard weeds cannot be raked off, they should be hand-gathered; and no dependence whatever should be placed on the destruction of any by the sun's rays until the 25th of June,—a time when on most soils the sowing should be concluded. It is desirable that the land should lie a week or ten days before the last ploughing is given to it, in order to admit of the germination of such seeds of weeds as may be lying dormant in the soil, and also to afford favourable scope for the accumulation of moisture in a dry season. In the Scotch practice, especially, all land intended for turnips is ploughed as soon as convenient after harvest; and, if even the slightest tendencies exist to retain wetness, it is carefully water-furrowed, in order to lay it completely dry; and, as early in spring as the other duties of the farm will permit, it is subjected to the utmost force and diligence of the whole strength of the teams and the work-people, to reduce it to the finest tilth by repeated ploughings, harrowings, and rollings, and to clean it thoroughly of weeds by the most careful and persevering grubbings, gatherings, and cartings. See the articles Fallow and Ploughing.

The Manuring of Land for Turnips.—A just or skilful enquiry into the most efficient system of manuring land for turnips ought to take account of the comparative market values of the several manures proposed to be employed,—of their influence upon the prompt and rapid early growth of the rising crop, such as shall enable or assist it to escape havoc or destruction from insect depredation,—of their effect upon the development and maturation of the roots, in reference to the bulk and weight of the ultimate produce,—of their control over the chemical constitution of the roots, both with regard to their general feeding and fattening power upon live stock, and with regard to the particular principles which they may most abundantly return to the land through the medium of the farm-yard,—of their capacity of co-operating with the process of feeding-off, for producing the greatest and most harmonious enrichment of the soil,—and of their prospective adaptation to the uses of the succeeding crops of the rotation, their

power to yield due nourishment to each of these crops, and their capacity of resisting too rapid decomposition, or of remaining with sufficient permanency in the soil to give out their principles only as they are wanted, on to the end of the rotation. It is therefore an enquiry of vast comprehensiveness and almost bewildering complexity; and might, both pertinently and profitably, be made to comprise the whole themes of both manure and rotation, or almost the entire science of agricultural chemistry, together with all its most important practical applications. We clearly could not discuss it here without very largely repeating what we have said in other articles; and we must refer intelligent readers, for both the general principles and some of the chief details by which they may work out the enquiry for themselves, to our articles MANURE, FARM-YARD MANURE, BONE-MANURE, GUANO, NITRATES, and AGRICULTURAL CHEMISTRY; and we shall here do no more than first borrow from an able writer in the Yorkshire Agricultural Society's Transactions, a statement of the most approved prevailing empirical practice of experienced farmers in some of the best agricultural districts of the country, and next mention one or two facts, by way of hint and specimen, respecting the action of special manures, both as used alone, and as used in combination with farm-yard manure and special composts.

"In treating of manures with which the turnips should be dressed," says Mr. Milburn, the Yorkshire writer, "farm-yard manure stands the foremost, because it is what every farmer possesses, and, with the exception of the calcareous soils in the East Riding of Yorkshire, is almost invariably employed in the cultivation of turnips. In general, it never will and never can be superseded; and though every deference is due to the practical knowledge of the East Riding farmers, there can be no doubt that if their straw were more carefully made into manure and applied to the turnip crop in conjunction with bones, it would be decidedly advantageous. It is necessary to say that house-made manure, and by fattening cattle, especially such as are consuming artificial food, is the best, and that of horses, cows, pigs, &c., should be mixed as intimately as possible, the hot character of horse's dung neutralizing the coldness of that of the cow, and *vice versâ*. It is desirable to cart this mixture to the fields intended for turnips in January and February, during the frost, or at such other times as convenience may dictate, but the earlier the better. About three weeks before used, it should be turned over the sides of the mixen, being carefully turned into the middle. Without entering, in particular, into the much disputed question of the fermentation of dung being useful or otherwise, thus much every farmer will know well the truth of, that on light soils, and for turnips, well-rotted dung is indispensable where it is used at all. When fermentation is progressing so fast as to induce destructive heat or mouldiness, it may be checked by treading the mixen, and covering it with soil; and when it is sluggish, it may be excited by turning and watering. For sandy or gravelly soils, farm-yard manure is an almost necessary ingredient in producing a crop of turnips. The rapid decomposition of vegetable matter which takes place on such soils requires that there should be a supply for that succulent crop; and, as before stated, there can be no doubt of its utility to calcareous soils; but for peaty descriptions, where there is abundance of vegetable matter, it is less useful. The time for laying on the manure depends on the method of sowing adopted, and clearness of the land from weeds. If the plough-drill be used, it is desirable to immediately precede the plough; if the Norfolk, or large drill, it is better to lay it on a week or two before sowing, to allow it to mix intimately with the soil, especially if other manure is intended to be used, and the soil pretty free from weeds. The quantity to be applied will vary with circumstances; twelve to fourteen tons per acre may be stated as an average, and more, if the soil be poor, and no other manure intended; while less may be used, in proportion as other manures are applied.—Lime stands next in importance as a dressing. The object of all manure is to supply some deficiency, remedy some mechanical inconvenience, or correct some detrimental agent in the soil. When dung, for instance, has been applied for several successive crops, a quantity of undecomposed vegetable matter accumulates, which the natural soluble properties of the soil cannot dissolve, and it remains inert. A dose of lime will correct this, and will bring every particle of such inert matter with which it comes in contact available as food to the plants. It also assists in the intimate pulverization of the soil, as well as corrects any acidity which may exist in it from causes which the agriculturist can seldom foresee or correct, except by its use. It is also destructive to weeds in the soil, and hence exceedingly valuable, for every farmer knows that weeds, being indigenous, are much more ready to grow in the soil than his crops, which are artificial, and often exotic. For peaty soils, an occasional dressing of quicklime is invaluable, especially if there is an addition of clay, road-scrapings, &c., to give the requisite firmness to the soil. It should be laid on as soon as convenient after bringing from the kiln, and in as hot a state as possible. The time for laying on lime is a few weeks before the sowing, in order that the subsequent ploughings may mix it thoroughly with the soil, and thus its effects be more immediate after the sowing. The quantity per acre entirely depends upon the character of the lime in the locality. Two or four chaldrons per acre are used; but as it is applied for turnips generally, in conjunction with other fertilizers, the former may be stated as the better quantity. If dung is also applied,

they should be used at as great a distance of time between each other as circumstances will admit of, and the latter not long before the sowing.—Bones form one of the most valuable manures for turnips on all light soils, on account of their portable and stimulating character; they are least useful on a gravelly or loamy soil. They have converted barren moor lands into rich, fertile, and productive farms, luxuriating in every valuable product of the earth. Their value is beyond all praise. The East Riding of Yorkshire affords a specimen of what they have effected, and they require only to be known to be extensively applied. In many cases, they are used alone; in others, in conjunction with farm-yard manure, with ashes, and with lime. Ashes are sometimes drilled with them as a substitute, by diminishing the quantity of the bones. Lime is a valuable auxiliary on old-going land, or soil which has been long under cultivation. On peaty soils, having a substratum of sand, they have produced wonderful crops, by supplying them with the necessary animal matter. The quantity varies from twelve to thirty bushels per acre. Sixteen bushels per acre will produce a fair crop on average soils, and some farmers say that more than that quantity is waste. It is desirable to mix them with a quantity of ashes when they are drilled in the above quantity. This facilitates the early progress of the plants, and supports them until the bones become available. English bones are generally preferred to foreign; but, from experiments made by the writer, he prefers foreign to English, and also to recent bones; for, although the latter have more of their juices than the former, the former sooner decompose, and the fat and animal juices require considerable chemical changes before they are available as food for the plants. A mixture might be judicious; but he has not tried it, nor is he aware of trial having been made.—Other manures of a miscellaneous character are used for turnips. Pigeons' dung is most valuable; rape-dust has been used successfully; and animalised carbon has also been advantageously employed."

Some of the most important special manures which have been experimented with are guano, the nitrate of potash, the nitrate of soda, poudrette, and Poittevin's manure; but the comparative values of these, and of bones, rape dust, animalised carbon, and other peculiar substances, both in their immediate action on turnips, and in their power over whole rotations, are glanced at in the section on special manures in the article MANURE; and the results of many experiments are stated both there and in some of the articles on the several substances themselves. The joint use of several special manures in combination with one another or with farm-yard manure, especially if conducted with intelligent regard to the precise chemical condition of the soil, and to the precise aggregate wants of the several crops of a rotation, is far more fitted to achieve a high order of results than the wisest possible single use of any one special manure; and even when employed with reference to the mere turnip crop itself, and without any very intelligent application of the doctrines of agricultural chemistry, it has been found to act with very high efficiency. The following tabular view of the particulars of a comparative trial of various compounds, by Mr. Thomas Page, at Merriden in Surrey, is both curious and instructive, and may suggest more useful hints than could be conveyed by an elaborate disquisition. The soil on which the trial took place was a light blowing sand, very shallow, containing many rubbly surface stones, and immediately incumbent on sandstone rock, and lying at a considerable elevation and much exposed; and was broken up from grass as deeply as the plough could go, and cross-ploughed in April, and grubbed and cleaned with Biddel's scarifier and Grant's lever horse-rake; and drill-sown, at distances of 18 inches, with the manures and the red round variety of turnip seed, in the latter part of July; and all parts of it were equal in quality, and were equally treated. "On all the portions where dissolved bones were used, the plants came forwarder to the hoe than where they were not used; but beyond this there was not much perceptible difference in the appearance of the different parts, until from a month to 6 weeks had elapsed, when No. 7 began to grow less rapidly than the rest. At the end of between 7 and 8 weeks No. 1 began to fall off; and in a few days No. 2 followed. Further than this difference, the eye could hardly detect where the separation of each kind of dressing took place."

No.	Quantity of Land contained.	Description of the Dressings applied.	Quantity of each kind used, with their respective costs.	£ s. d.	Cost per Statute Acre. £ s. d.	Weight of Roots per Statute Acre. tons. cwt. qrs. lbs.	Weight of Tops and Tails per Acre. tons. cwt. qrs. lbs.	Total Weight of Produce per Statute Acre. tons. cwt. qrs. lbs.
1	a. r. p. 1 0 0	Crushed Bones and Turf Ashes.	8 bush. Bones, 2s. 6d. 16 „ Ashes, 5d.	1 0 0 0 6 8				
				1 6 4	1 6 8	9 1 3 20	3 0 2 16	12 2 1 36
2	1 0 0	Crushed Bones, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 bush. Bones, 2s. 6d. 16 „ Ashes ½ cwt. Soda, 23s. ½ cwt. Potash, 33s.	1 0 0 0 6 8 0 11 6 0 16 6				
				2 14 8	2 14 8	10 1 1 20	3 0 1 4	13 1 2 24
3	1 0 30	Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, and African Guano	4 bush. Bones 84 lbs. Acid, 1d. 16 bush. Ashes 1 cwt. Guano, 8l. 10s.	0 10 0 0 7 0 0 6 8 0 8 6				
				1 12 2	1 7 1	12 0 2 24	3 1 2 24	15 2 1 20
4	1 0 30	Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, African Guano, Nitrate of Soda, and Nitrate of Potash.	4 bush. Bones 84 lbs. Acid, 1d. 16 bush. Ashes 1 cwt. Guano ½ cwt. Soda ½ cwt. Potash	0 10 0 0 7 0 0 6 8 0 8 6 0 11 6 0 16 6				
				3 0 2	2 10 8	14 1 1 4	5 0 1 4	19 1 2 8*
5	1 0 0	Muck of an ordinary kind, African Guano, and Turf Ashes.	8 cart-loads of Muck, at 4s. 3 cwt. Guano 20 bush. Ashes	1 12 0 1 5 6 0 8 4				
				3 5 10	3 5 10	13 1 2 24	5 0 0 0	18 1 2 24
6	1 0 0	Muck, African Guano, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 loads of Muck 3 cwt. Guano 20 bush. Ashes ½ cwt. Soda ½ cwt. Potash	1 12 0 1 5 6 0 8 4 0 11 6 0 16 6				
				4 13 10	4 13 10	13 1 0 10	4 0 0 16	17 1 0 26
7	1 0 30	Muck, Crushed Bones dissolved in Sulphuric Acid, and Turf Ashes.	8 loads of Muck 4 bush. Bones 84 lbs. Acid 16 bush. Ashes,	1 12 0 0 10 0 0 7 0 0 6 8				
				2 15 8	2 6 0	7 1 2 26	3 0 1 20	10 2 0 18
8	1 0 30	Muck, Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 loads of Muck, 4 bush. Bones 84 lbs. Acid ½ cwt. Soda ½ cwt. Potash	1 12 0 0 10 0 0 7 0 0 11 6 0 16 6				
				3 17 6	3 4 10	12 0 0 0	3 1 1 4	15 1 1 4
9	1 1 0	Muck, Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, and African Guano.	8 loads of Muck 4 bush. Bones 84 lbs. Acid 1½ cwt. Guano 16 bush. Ashes	1 12 0 0 10 0 0 7 0 0 12 9 0 6 8				
				3 8 5	2 14 8	12 1 2 20	3 1 3 8	15 3 2 0

* By measure 820 bushels per acre, weighing 40 lbs. per bushel.

The widely different effects of different kinds of fertilizers upon the chemical constitution and the feeding powers of the turnip may be sufficiently illustrated from the case of guanoed and non-guanoed Swedish turnips. Two roots of Swedish turnip raised with respectively farm-yard manure and guano, and both furnished by the same grower, analysed by the same chemist, and almost exactly alike in the quantity of their contained water in a recent or undried state, have been found very materially different in the proportions of both their organic and their inorganic constituents. The farm-yard manured turnip, after being deprived of all its contained water, yielded 2·09 per cent. of oil, 2·27 of gum, 44·82 of sugar, 10·35 of pectic acid and albumen, 25·04 of meta-pectic acid, 10·18 of cellular or woody fibre, and 5·68 of saline matter and ash; and the guanoed turnip, after being deprived of all its contained water, yielded 1·26 per cent. of oil, 1·57 of gum, 13·59 of sugar, 5·88 of pectic acid and albumen, 56·09 of meta-pectic acid, 15 of cellular or woody fibre, and 5·8 of saline matter and ash. Both turnips contained nearly the same quantity, or about 69 per cent. of soluble matter in their ash,—but they differed widely in the proportions of the ash's most valuable constituents; for the ash of the farm-yard manured turnip comprised 9·72 per cent. of chloride of potassium, 45·49 of potash and soda, 1·23 of magnesia, 10·17 of lime, 17·86 of sulphuric acid, and 7·73 of phosphoric acid,—while that of the

guanoed turnip comprised 6·45 per cent. of chloride of potassium, 36·29 of potash and soda, 0·39 of magnesia, 11·56 of lime, 16·86 of sulphuric acid, and 19·39 of phosphoric acid. Two inferences may be selected from these facts as specimens of the instructive character of the whole,—and both are exceedingly obvious, and lie on the very surface of the analyses,—that the proportion of oil renders the farm-yard manured turnip about 50 per cent. more favourable for fattening, inasmuch as 100 lbs. of that turnip would supply fat enough for laying on 1½ lb. of live weight, while the same quantity of guanoed turnip would supply enough for laying on only 1 lb.,—and that the proportion of phosphoric acid renders the guanoed turnip incomparably more favourable for forming and building up both bone and muscle, the quantity of that substance being not far from three times greater than in the farm-yard manured turnip, and the quantity of it in the flesh of animals being about ⅓ lb. in every 100 lbs., and in the fresh bones of animals about one-fourth of their whole weight. So far then as these inferences go—as also on the ground of some experiments in feeding which our limits do not allow us to detail—the grand principle seems to be evolved, in regard to the most profitable chemical constitution of turnips, or in regard to their highest aggregate feeding powers, just as formerly in regard to their amount of produce, that the best results are to be attained by the joint use of widely different manures.

The Sowing of Turnips.—In the north of England and the south of Scotland, the usual time of sowing Swedish turnips is from about the middle till the end of May,—hybrid turnips, from about the beginning till the middle of June,—and of common turnips, from about the middle of June till a few days into July. But the best time of sowing, in any circumstances, is dependent considerably on the state of the weather and on the comparative forwardness of the season,—still more on the climate of the place and on the character of the soil,—and yet more on the variety of the turnip and on the intended time and method of using the crop. Any turnips sown too soon are apt to shoot forth their flowering-stem before winter, so as greatly to diminish the nutritiveness of the roots; any turnips sown too late incur a risk of not attaining full size and due maturity; and most common turnips sown at any period which does not allow of their being matured and used in the course of autumn are liable to become soft, spongy, and comparatively worthless.

The quantity of seed for any kind of turnip, in any method of sowing, may be somewhere between 2 and 3 lbs. per imperial acre; but ought to be greatest in kinds which do not admit of mending by transplantation,—in cases of broadcast sowing,—and in situations and seasons which threaten the worst attacks of the turnip-fly.

The Scotch or raised-drill or ridge method of sowing, especially on poor or thin soils, and whenever farm-yard manure constitutes the main or lower pabulum, is decidedly the best. The ridges are made either with a single cast of the double-mould-board plough, or a double one of the common or ribbing plough, and from twenty to twenty-eight inches apart. A cart with manure follows; and women are generally employed to drop the manure into the seams made by the plough. The plough again follows, and closes the ridges, covering the manure; and the drill succeeds, drawn by one horse, and sows one ridge at a time. A light roller goes over the sown ridges to cover the seeds, and sometimes the ridges are rolled before the sowing. This plan takes more time and labour to effect it; but the turnips generally succeed; and if they should be destroyed by the turnip-fly, they can be re-sown with more probability of success than by any other method.

The plough-drill method of sowing is proper only on deep good soils, and in cases where only very bulky manure is employed, or where the intentions of the farmer require the manure to be applied with reference less to the immediate crop than to the whole succeeding rotation. In this method, the manure is spread on the ground; and the plough follows, with the drill so fixed to its right hand side as to deposit the seed immediately in the seam made by the plough.

The large-drill method of sowing on the level surface is the method most expeditious in execution, most suited to the deposition of special manures, and most generally in use throughout the best agricultural districts of England. The peculiarities and advantages of it vary with the different kinds of machines employed for depositing the seeds and the manure, and may be pretty well understood from the account we have given of these implements in the article Sowing-Machines. A single light harrowing is commonly given after sowing with any kind of large drill; and when much heavy rain succeeds, another turn of the harrows may advantageously be given before the land becomes dry, in order to prevent it from scraping.

The old broadcast method of sowing was to spread on the manure, plough it in, and then very carefully sow the seed with the hand. This practice is almost everywhere abandoned; nor can it in any case be recommended or justified. "All the effect of broadcast sowing," remarks Martin Doyle, "can be attained by a drill machine, constructed for sowing at twelve-inch intervals, which is more economical, and operates more regularly, than the most experienced hand. As we by no means maintain the necessity of having ridgelets on sandy land, requiring consolidation of surface, uniform retention of moisture, and adaptation for sheep-folding—the narrow unraised drills, which are a close approximation to broad-cast culture, may, in such

circumstances of soil, and with a view to feeding off the crop on the field, be the best, on the supposition, however, that the manure is of such a nature as can be scattered by hand over the entire surface, or deposited with the drill implement."

The After-Culture of Turnips.—The proper management of a turnip crop, from the time of sowing till the time of maturity, consists in thinning or "singling" the plants to the proper distances, and in a series of operations for destroying weeds and stirring the soil; and, though somewhat modified by differences in the variety of the turnip, in the character of the soil, and in the method of sowing, it is always the same in principle, and may be sufficiently exemplified in all cases by the usual details of it in the case of ridge-sown hybrids.

When the plants acquire the rough leaf, or are about two inches high, or begin to be incommoded by weeds, or about three weeks after sowing, the process of hoeing commences. The first hoeing is done either by a small one-horse plough going and returning along the hollow of each ridge, and cutting off a slice of earth from the sides as near as possible to the turnips, or, more conveniently, by a horse-hoe with lateral coulters passing once along each interval. A few days after this operation, the hand-hoers go to work, each having a little iron hoe, fixed upon a wooden handle about 3 feet in length; and, standing in the hollow with their faces to the ridges, they so hoe the turnip-plants as to leave them standing singly at the distance from each other of from 8 to 12 inches. By this operation, the rows of the turnips are cleaned of all weeds,—the superfluous plants cut up, and pushed into the intervals, where they die,—and the plants to be preserved left standing singly at the distance required. Soon after, weeds will again sprout up in the intervals of the ridges and amongst the plants; so that in the course of 12 days or more, the horse-hoe again passes through the intervals of the ridges, cutting up all the weeds that may have sprung up; and soon after the hand-hoers again go to work with the same instrument as before, cutting up all weeds which may have grown amongst the turnips, and carefully singling any plants that may by chance have been omitted in the first hoeing. Sometimes the horse-hoe, after a short period, passes once more down the intervals; but more generally, the second hand-hoeing concludes the process upon all the drier lands, the weeds being thenceforth kept down by the rapid growth of the plant, and by the overshadowing of the intervals with its leaves. In many instances, however, at an interval of 8 or 10 days after the last hand or horse hoeing, the earth which had been taken from the roots of the plants by these several hoeings, is again laid back, either by the small one-horse plough or by the double mould-board plough passing down the intervals of the rows, and ridging up the earth. The design in this operation is, that any weeds which remain in the intervals, after the former hoeings, may be destroyed, and that the land and turnips may be kept more dry during wet weather and the months of winter. The plants now grow rapidly without farther care; and, by the beginning of September, the leaves of a good crop will have covered the entire surface.

The most important variations in the modifications of after-culture adapted to other cases of turnip-crop than ridge-sown hybrids, concern the distance left between the plants in the operation of singling. And in the case of swedes on good land, this distance ought not to be less than from 12 to 15 inches,—while, in the case of most common turnips, upon almost any kind of land, it ought not to be more than from 6 to 10 inches; for swedes of large size contain greater nourishment, weight for weight, than swedes of small size,—while most kinds of common turnips of large size contain, weight for weight, less nourishment than the same kinds of small size. "As regards the quality of the land, too, it appears that Nature, in destining these two varieties of turnip to be better adapted for two distinct varieties of soils, has also ordained that each soil will be respectively benefitted by that crop which it is calculated to grow to the greatest perfection than by that of an opposite character. Thus it is that Swedish turnips, grown on a heavy soil, at considerable distances asunder, will admit of applying a superior tilth, together with a free action of atmospheric and solar influence on all the vacant spaces, thereby effecting all the good that could be expected from a naked fallow without being alloyed by any of its evils; whereas an open or porous soil, being that best adapted for rough-leaved turnips, will, by such a crop being suffered to grow thick, possess those advantages which it stands so much in need of, namely, a shade from a scorching sun, tending thereby to assist the secretions of the crop, and add to the vegetable staple of the soil."

The Consumption of Turnips.—A common method of consuming turnips is to have them eaten off by sheep. In this case, the turnips are either pulled up by hand, and carried away, as wanted, into the fields in which the sheep are kept, and there spread regularly on the ground; or, more frequently and economically, they are consumed on the field where they have grown, by folding the sheep upon it, and allowing them to eat the plants on the spot. See the articles Fold, Hurdle, and Sheep. One method of feeding off on the spot, is to allow as much of the turnips as the sheep can reach to be eaten just as they stand, and afterwards to pick up the "shells" or bottoms of the roots with a pronged hoe; and another is to allow them to eat only the tops as they stand, and then to take up the roots and slice them into pieces, by means of some one or other of the implements noticed in our article

Turnip-Slicer, and either to leave the pieces scattered on the ground in the immediate vicinity of the place of growth, or to deal them out in feeding-troughs. The design of slicing is to protect the teeth of hoggets and old sheep; and the design of using troughs is to protect the mouths of all sheep, but especially fattening ones, from the dirtiness of the land. The grand use of eating off turnips on the spot, whether whole or sliced, with troughs or without them, is to enrich the land with the refuse of the crop and the droppings of the sheep, and to work and consolidate it into prime condition for the succeeding grain crop by the treading of the sheep's feet and the recumbency of their bodies. A common practice, in all the varieties of this usage, is to place within the fold a small portable rack containing some hay, which acts as a condiment and corrective of the great succulency of the turnips.

Other methods of consuming turnips are to have them carried to the farm-yard, and there given to cows, to store-cattle, and in some instances to horses; and in all such cases, they must be twisted out of the ground by the hand, and deprived of their leaves and tap-roots on the spot by the stroke of a knife or a sickle; and such as are not immediately or very soon to be used, must be stored in some one of the ways to be noticed in next section. The suitable time for taking up most of the varieties is about the beginning of November, or previous to the commencement of the winter frosts; and the condition of soil and weather most advantageous for the operation is after some little time of drought. The act of pulling each plant should be a sharp twisting motion, such as shall freely bring up the whole plant and disengage the soil from its roots; and the acts of lopping off the leaves and the tap-roots, technically called topping and tailing, should be done with as much exactness as possible, so as neither to leave much green or loose matter nor to wound the skin of the root; for when a portion of the leaves is left, it tends to make the turnip vegetate on receiving a slight degree of heat,—and when a wound is inflicted on the skin, it tends to make the turnip rot. All turnips used raw in the farm-yard, require to be sliced before being given to the cattle.

A method of consuming the hardiest varieties of turnips, intermediate between feeding them off with sheep and storing them before winter for farm-yard use, is to leave them alone where they stand, and either to pull up occasional supplies of them in fresh weather, for the use of sheep in pastures or of cattle in the farm-yard in periods of snow or severe frost, or to take them up piecemeal in all sorts of weather as they are wanted. But when taken up during frost, they are often so hard and so firmly fixed to the ground, that they can be raised only with some such implement as the hoe, and not without great labour; nor can they be easily or suitably eaten, unless they be thawed by being placed for a few hours in a pool or running stream, or for ten or twelve hours in some warm house in which cattle are kept.—A modification of this method, of such a nature as partially to combine with it some of the advantages of storing, is described as follows in the Useful Knowledge Society's Treatise on British Husbandry:—"The turnips are drawn by means of a two-pronged hoe or bent fork called 'a grubber,' in the months of November and December, and the bulbs are placed, with the top entire and only a small portion of the root cut off, in the centre furrow, upright, making one furrow contain the plants which grow upon two or three ridges, and taking care that the bottom of each plant shall touch the ground. The soil is then ploughed up to them, covering the outer edges; and if the weather be very severe, a little straw or any species of litter is thrown over them. Those that remain unconsumed in February are then removed to the quarter where they will be required for consumption, and placed as close as possible to each other upon grass land, having then the remainder of the root cut off. This plan has the advantage of preserving the turnips in the best order, alike free from exhaustion by growth and from decay by too much exposure, as well as preventing the attacks of wood-pigeons and crows, which commence their depredations at the season when their usual food begins to fail. The soil is also less deteriorated by this mode, than it would be by allowing the plant to remain in the land."

The Storing of Turnips.—The chief reasons for storing turnips are the necessity, on most systems of winter-feeding, and in all districts where wintry weather is severe and of long continuance, and where snow falls in large quantities and lies long on the ground, of having available supplies in constant readiness for the use of stock,—the expediency of clearing land, for the sowing of any particular crop, previous to the time at which it may be convenient to consume the turnips,—the advantage to both the land and the crop, in all cases where the soil or subsoil is of a stiffish nature, or has any tendency to become retentive, of removing the turnips before the season when moisture becomes prevalent and evaporation becomes low,—and the preservation of the bulbs of the less hardy varieties from the destructive actions and accidents to which they would be liable if allowed to remain in the field.

The common method of storing turnips is to build them in a piled heap, of the form of a potato pit, in a dry and airy situation, conveniently near the place where they are to be consumed; and to cover the heap with straw, and make it secure with ropes,—and to have all the turnips as clear as possible of earth, and not to use any in covering the heap, as it tends to induce heat and either vegetation or fermentation. But

this method is adapted for only the Swedish and the hard hybrid varieties,—as all the white kinds and some of the softish yellow ones possess too much water to be preserved for any length of time; and another method is often practised with the latter, by what is called placing. The tap-roots being taken off, the bulbs with the leaves are placed close together in the position in which they grew, upon some dry place, near to where they are to be consumed; and in this way they will keep longer than if they had been left in the field, as they are not so apt to run to seed. But even the placing system has its objections; for if a tract of dry weather set in, the turnips, from being merely on the surface, become soft and shrivelled, and not so palatable to the cattle, and will even continue so for a considerable time, although the weather should be rainy, until the fibres begin to take hold of the soil; and another objection is, that if the turnips are not placed near the steading, the destruction from game, hares, wood-pigeons, &c., is very great, particularly if the turnip be Swedish. In order to remedy these objections, a third method has been adopted, which has been found to answer every purpose intended. The turnips are brought from the field, without either topping or tailing, to a piece of dry ground near the straw-yard; then a man, with one horse in a plough, makes a straight furrow; the turnips are placed in the furrow, quite close together, till the whole is filled from end to end; then the man with the plough moves round to where he commenced, drawing another furrow quite as close to the turnips as to enable him to cover them; and so on alternately —the men making the furrow and covering the turnips, while the women and girls lay in the turnips. By this method the turnips keep as fresh, preserving all their natural juices, and are as well relished by the cattle, as though they were taken direct from the field. The Report of the Harleston Farmers' Club for 1839, affirms that the best method of preserving roots during the winter is by clamping them, both as regards protection from frost and maintaining their quality, and that the following is a very effectual method of making the clamps:—Select a convenient and dry situation, and pack the roots carefully, with their crowns outside, in a row about six feet wide at the bottom and terminating in a narrow ridge at the top; then dig a trench commencing immediately at the edge of the roots, two feet wide and one deep, turning the mould from the heap; thatch the latter carefully with straw, commencing in the trench, so that all the rain may drain off the heap into it. The clamp may be left two or three weeks in this state, that the evaporation from the roots may escape. The mould already taken out of the trench is then to be laid on the straw, commencing at the bottom of the thatch and covering the heap twelve inches thick throughout, finishing with a sharp edge. Half the trench originally made will, of course, by this plan, be filled up with straw and mould; the other half will remain as a channel for the water falling off the heap; and as sufficient mould will not have been raised from the original excavation, it will be advisable, in procuring more, to make the channel made round the heap a few inches deeper, as well as wider. If the roots are stored late in the season, and the probability of frost setting in renders it necessary to cover the heap with mould as soon as it is made, it would be better to leave the top uncovered for a week or ten days longer, that the heat may escape. There is no objection to the roots being wet and dirty when they are clamped; the tops should be cut off, but not too close to the crown; the roots and fibres should be left on.

The Diseases and Accidents of Turnip Crops.—The extensive and constant cultivation of the turnip has fostered the rapid increase of its natural enemies; and after all the expense, labour, and precautions of even the most skilful cultivator, he sometimes sees his crop seriously injured or entirely destroyed. He can apply at best only palliative remedies; yet he has much in his power; and, when science and discovery shall become more thoroughly blended with agricultural practice, he may hope to acquire means of preventing or obviating every form of disaster. The chief of the many diseases and accidents of the turnip are fully discussed in the articles Turnip-Fly, Anbury, Wire-Worm, Aphis, and Slug; and, for the sake of connected view, they may here be briefly noticed in the group.

The turnip flea-beetle, *Haltica nemorum*, is one of the worst enemies, and attacks the turnip plant in its seed-leaf state, and often destroys a crop, and even the second and third sowings. Various steps have been taken in order to prevent its attacks, and several steeps for the seed used, but without success. Top-dressings of a saline and astringent character have been applied, but have failed. Machines even have been invented; but none have succeeded. The only directions which can be given are, to sow plenty of seed, to use stimulating manure in order to excite the plants to vigorous growth in their first stages, to secure a sufficiency of moisture in the soil at the time of sowing, and especially to keep seedlings in turnip-fields clear of charlock, which nurses the flea.—The black caterpillar larva of the *Athalia spinarum* also preys upon the leaves in a more advanced stage, appearing on the plants when they are about three weeks old.—Another disease to which the turnip is liable is vulgarly called fingers and toes. About a month after the plants have made their appearance, they begin to flag their leaves, and in a few sunny days literally die by acres together. On examination, the fibres of the roots are found enlarged, and the roots covered with tumours

and excrescences of every conceivable shape. A naked fallow is a remedy for it; but all applications to the soil and plant have been ineffectual. —The wire-worm is a sad enemy.—The swarms of aphides, or plant lice, severely injure the turnips, and from the smallness of their size are often unobserved. In 1836 they committed terrible ravages. They suck the juices of the plant, and appear in countless numbers. They are both oviparous and viviparous, and increase with amazing rapidity. Happily they are always followed by swarms of lady-cows, which feed on them, as well as insectivorous birds which destroy vast numbers. No remedy can be applied with any probability of success. Every farmer should carefully protect swallows, red-breasts, &c., which are great destroyers of the aphides.—Slugs, especially on newly-ploughed soils, are great devourers of the turnip plant in all its stages. Ducks will devour them, but always injure the plants. Three bushels of quick-lime per acre, scattered over the plants early in the morning, when the slugs are active, is a certain method of destroying them.—Perhaps the very best preservative from all the diseases is liberal manuring, adapted to the soil, thorough cleaning of the land from weeds, and in short pursuing whatever measures are best for securing a full crop. The vigour of the plants in such cases, and their rapid vegetation, often enable them to overcome many serious attacks.

The Produce of Turnip Crops.—An ordinary or average field turnip, of the kinds most commonly cultivated in Britain, weighs about 6 or 7 pounds; and one of a large variety, grown under the most favourable circumstances, weighs from 20 to nearly 30 pounds. A calculation has been made that one ounce of turnip seed contains from 15,000 to 16,000 seeds,—that therefore each seed weighs only about a 15,000th or 16,000th part of an ounce,—and that, when developing itself into a plant whose cauline bulb has an average weight of about 6 or 7 lbs., it must, on the supposition of an uniform increase of substance during the period of growth, acquire 15 times its own weight in a minute; and by an actual experiment, made on peat soil, it was found that turnips, during the period of their growth, made an average daily increase of 15,990 times the weight of the seeds from which they sprang. "It is not, however, only the size and weight of the root," remarks a popular writer, "which renders the turnip crop so productive. The number contained in a given space, with reference to their size, is very great. Some writers speak rather marvellously on this subject; but it is generally thought to be a good crop when a turnip is obtained from each square foot of ground. Mill considers an average crop to be 11,664 roots per acre, which, at 6 lbs. each, will be 69,984 lbs."

The amount of any one turnip crop, however, is powerfully affected by the condition of the soil, the stage of the rotation, the kind and quantity of the manure, the method of culture, the character of the climate, the prevailing weather of the season, and the particular variety of the plant. A light soil will never produce a maximum crop of Swedish turnips; nor a heavy soil, a maximum crop of common turnips; nor an ill-tilled soil of any kind, a maximum crop of either. A suitable soil in a freshly manured state, or at the commencement of a rotation, will produce, on the average, from 28 to 33 tons per acre; while the same soil, after an intervening crop from the manuring, or in the second year of a rotation, will not produce, on the average, more than from 6 to 8 tons per acre. Different plots of one field of strictly homogeneous characters, treated in exactly the same way, and cropped from one specimen of seed of one variety of turnip, but fertilized with different kinds and composts of good manure, will, as we showed in the section on the manuring of the turnip, yield very widely different produce, both in quantity and in quality. The drill culture, in any given circumstances, will always produce a better crop than the broadcast culture; and the raised-drill culture, in adverse seasons, will generally produce a better, and sometimes very much better, than the large-drill and flat-surface culture. The comparatively cool and moist climate of Scotland and the north of England constantly produces a much larger average turnip crop than the comparatively warm and dry climate of the south of England; and for the same reason, a hot and droughty season will diminish the average in the former districts, and a cold and wet one will increase it in the latter. As to the comparative weight and size of the roots of different varieties, "it has been found, after repeated trials, that sound green-top yellows, of 7 or 8 lbs. weight, gave, as their highest average, 32 cubic inches per pound; which may be assumed as a medium standard of solidity or density, and being compared with the actual weight, will afford a just criterion of their value, and a correct idea of their sizes. Thus, by dividing the number of cubic inches contained in any bulb by 32, (the remainder being halved for 16ths or ounces,) the quotient gives the number of pounds and ounces that should be of the standard solidity; the actual weight of the bulb will indicate the solidity, which will either be at, or above, or below the standard—as the numbers of the weight are equal, or greater, or less than the numbers of the size." Specimens of some of the chief varieties, grown upon different soils and carefully selected, were put to the test on this principle, at Messrs. Drummond's establishment in Stirling, and gave the following results:—

	Weight per standard.	Actual weight.
Swedish turnip,	11 lb. 2 oz.	13 lb. 12 oz.
Ditto,	10 lb. 5 oz.	13 lb. 8 oz.
Green-top yellow,	16 lb.	15 lb.
Ditto,	15 lb.	14 lb.

	Weight per standard.	Actual weight.
Red-top yellow,	12 lb.	12 lb. 10 oz.
Ditto,	11 lb. 8 oz.	11 lb. 12 oz.
Dale's hybrid,	13 lb. 12 oz.	12 lb.
Ditto,	12 lb. 8 oz	11 lb. 8 oz.
White globe,	20 lb. 8 oz.	15 lb. 8 oz.
Ditto,	19 lb.	15 lb.
Red-top white,	16 lb. 8 oz.	13 lb.
Ditto,	14 lb. 8 oz.	12 lb.
Green-top white,	12 lb.	11 lb.
Ditto,	11 lb.	10 lb. 8 oz.
White tankard,	16 lb.	14 lb.
Purple tankard,	12 lb. 10 oz.	11 lb. 8 oz.

It will readily be seen, then, that the produce of turnip crops is exceedingly variable, and not a little difficult to be estimated. In rare cases, it has risen so high as 60 tons per acre, and fallen so low as next to nothing; and in ordinary cases, it ranges throughout greater part of the enormous interval between these extremes; and in average cases of good culture, at the commencement of rotations, or immediately after manurings, it may be set down at something between 28 and 32 tons per acre.

The value or price per acre is even more variable than the weight; for, besides being dependent on the quantity, and therefore controlled by all the same circumstances which control the weight, it is affected also by the special feeding qualities of different specimens of each variety,—by the capacity of each crop, under the varying characters of weather and season, to keep well, and become readily available for winter and spring food,—and by the market fluctuations which result from the aggregate relations of supply and demand. On the whole, however, the turnip crop, regarded simply by itself, or without reference to its place in rotations and to its aid to store-feeding, is never remunerating; and, as compared to the average value of the other crops of a rotation, is commonly and roughly yet somewhat correctly estimated as worth about half a crop.

Forage Crops of Turnip.—The early stone turnip is sometimes cultivated in England, in a manner supplementary to the ordinary feeding crops of the farm, either by being sown on the first-cleared piece of wheat-stubble, and used for spring food, or by being sown in the beginning of July, and used for September food. In the former way, it sometimes answers well, but at other times yields only a scanty bite of green leaves for couples in spring; and in the latter, it commonly succeeds well, and is consumed by being led out to the fields where the cattle are depastured, or upon the stubble immediately after harvest. It is popularly called by the farmers who cultivate it the stubble turnip; and may have got that name either from being sown on stubble land in the one way, or consumed on stubbles in the other. It is a rapidly growing variety, and can be profitably used only two months after it is sown, though it will continue to increase in bulk for a longer period; but it is comparatively very soft and succulent, and seldom acquires a maximum weight in the root of more than about 7 pounds, and it has a tendency to flatness of the top, and is in consequence unsuitable for a winter turnip. It may easily be raised with bone-dust or guano, or with a mixture of either and rape cake.

Any ordinary field turnip of the common or the hybrid kinds may be thinly sown, in the quantity of about 2 lbs. of seed per acre, among the plants and interstices of a bean-crop just before it is hoed for the last time; and if the land has been well tilled for the beans, and has been once horse-hoed or hand-hoed, it will be in pretty good order for receiving the turnip seed, and the young turnip plants will be not at all checked, but rather fostered, by the shade of the beans. If the land be intended for winter wheat, the turnips, as soon as the beans have been carried, are drawn and stored; but if not, they remain to be folded off in the same manner as ordinary turnip crops. One grand objection to this method, however, is that the soil most suitable for beans is far from being suitable for either common or hybrid turnips; and another is that the double crop of beans and turnips abstracts an extraordinary amount of nutrimental matter from the soil, and correspondingly impoverishes it for the succeeding corn crop. But the former objection is mitigated by adopting the practice only on soil of a medium character; and the latter, by prospectively enriching the land, in a superior degree, at the time of manuring.

The repeated cutting of the tops of transplanted Swedish turnips has been recently proposed as a probably good expedient for obtaining large supplies of green food to stall-fed cattle, and was first suggested by an accidental discovery on Mr. Johnstone's farm of Larg-Liddesdale in Galloway, in the summer of 1847. Seedlings of Skirving's swede, sown early in April, were transplanted on the 22d of June; and some began, in the course of from 10 to 20 days, to run to flower,—and were cut over, pretty near the base of the stem, as soon as they went into flower,—and afterwards increased their roots, and sent out a luxuriant growth of new and very delicate stems and leaves, —and were again, at two successive periods, cut over as before, and sent out, after each cutting, a new growth of tender foliage; and at the end of the season, after having yielded a great weight of excellent green food, they had larger bulbs than the swedes of the same field and from the same bed which had not run to flower, and had been allowed to grow in the ordinary way; and one of the bulbs, on being subjected to analysis in the laboratory of the Agricultural Chemistry Association of Scotland, was found to contain so high a proportion of water as nearly 91 per cent., but to be in other respects about as nutritive as the average of Swedish turnips. "The value of this experiment," remarks the intelligent reporter of it, "might depend upon a variety of minute particulars, which should be carefully investi-

gated and stated. When plants were old and predisposed to run to seed before transplanting, they were thrown aside; and transplanted roots, when flowering, were usually looked upon as lost, and pulled up or allowed to run to waste. What in Mr. Johnstone's case had secured success? Was it his having saved his seed early so as to predispose to flowering, and then, taking them up, transplanting them shortly before flowering, and cutting them immediately after they had come into flower? As to the bulbing of the plant, too, was its regularity and success influenced by the cutting of the stem close down, say about half an inch from the turnip? It was very clear that if this practice could be adopted as easily and cheaply as practised by Mr. Johnstone, the system of turnip cropping would be revolutionised completely; the growing of rape and other green foods would be dispensed with; as the turnip, so transplanted, could be put in so as to afford most abundant and nutritious green food for cattle and pigs during summer as well as large roots as food for winter."

The Raising of Turnip Seed.— Good turnip seed is obtained, in small quantity, only from transplanted, large-bulbed, vigorous plants,—and in large quantity, from an untransplanted crop raised immediately from the seeds of such plants; and, in order to its being true to the variety, or unaffected by indefinite natural hybridizing, it must be raised, from first to last, in a situation which cannot be reached by the pollen of any other kind of turnip, or by that of cabbage, borecole, rape, or any other kind of brassica. See the article BRASSICA. The seed of a turnip plant, which runs up to flower without previous transplantation, is generally more or less degenerate; and that of even a carefully transplanted and perfectly suitable turnip-plant, which flowers in the vicinity of some other sort of brassica, is very liable to be injuriously hybridized. The proper time for transplanting is the month of February.

Persons who professionally raise turnip-seed in large quantities for the market annually select from a growing crop a number of the best-formed and most healthy roots, and transplant them into a plot of finely tilled and well-manured soil. The roots are placed in regular rows, by hand, in hollow drills, previously made by the plough; and the intermediate ridgelets are split open to cover them, leaving the crowns bare. No particular after-culture is given, except to keep the ground free from weeds, by means of the hoe. When the pods fill and the seed begins to harden, the crop must be carefully watched, to prevent the depredations of small birds; and the stalks ought to be cut before the seed is completely ripe, as in that state the pods are extremely apt to split open in handling, and to spill the seed. When the stems are sufficiently dried, either the crop may be thrashed out immediately, and the seed put into a dry granary, or the crop may be secured in ordinary ricks, carefully thatched like corn-stacks, and thrashed out in spring. The produce of this transplanted crop is sown in the succeeding year, and is not transplanted; and the seed of this second crop is saved for sale, and is then sold under the name of transplanted turnip-seed. Thus, having two breaks of seed turnips, the cultivator may always keep up a stock of excellent seed; and so also may every farmer who chooses to take the trouble to go through the process for himself. But the seed per acre is so cheap, as hardly to be worth the necessary pains and attention, except to those who do it to some considerable extent for sale. One acre of ground may produce to the value of £50; but any considerable extension of the culture would soon greatly overstock the markets. Farmers, however, who raise their own seed, besides saving the price, have this additional advantage, that they are always sure to obtain good sorts; and those also who possess a rare or very excellent variety may do well to raise their own seeds of it, rather than incur the risk of not obtaining it genuine from a seedsman, or perhaps of not obtaining it at all.

The Chemical Composition of Turnips.—Both the entire chemical constitution of the bulb of Swedish turnips, and the manner in which it is affected by the circumstances of growth and culture, were formerly noticed in the section on the manuring of turnips. The comparative nutritiousness of the bulb of some of the principal varieties may be understood from the following statement:—64 drachms of Swedish turnip afford 110 grains of nutritive matter, 64 drachms of stone turnip afford 85 grains, 64 drachms of white round turnip afford 83 grains, 64 drachms of white globe or white loaf turnip contain 80 grains, and 64 drachms of white tankard turnip contain 76 grains. "Turnip," says Boussingault, speaking apparently of the common white varieties, "is the most watery root I have examined. A slice weighing 2 oz. 17 dwts. dried in the stove, was reduced to 4 dwts. After thorough desiccation, one of turnip weighed 0·075; consequently the root contains 92·5 per cent. of water. One of dried turnip incinerated left 0·0758 of ash; and the composition of the whole was 42·8 per cent. of carbon, 5·54 of hydrogen, 42·4 of oxygen, 1·68 of azote, and 7·58 of ash." But both the proportion of water, and the quality as well as the amount of the nutritive matter, in any variety, from the hardest swede down to the softest globe or tankard, are very considerably affected by soil, climate, weather, manure, culture, and stage of maturity.

The chemical composition of turnip leaves, both absolutely and at successive stages of growth, is an interesting subject of enquiry in connection with the hope which now exists of the capability of the plant being so managed as to yield a succession of cuttings of green forage; and though this has not yet, so far as we know,

been made a subject of investigation in the case of the Swedish turnip, it has, in some degree, been very elaborately ascertained in the case of the white globe turnip, and may be supposed to be not very dissimilar in the case of any of the other rough-leaved varieties, or even in the case of the swede. Some of the chief facts and deductions brought out by experiment were that, on the 28th of June, the fresh leaves contained 88·61 per cent. of water and 2·48 of ash, and the dried leaves contained 21·8 per cent. of ash,—on the 26th of July, the fresh leaves contained 88·46 per cent. of water and 1·84 of ash, and the dried leaves contained 15·95 per cent. of ash,—on the 30th of August, the fresh leaves contained 86·61 per cent. of water and 2·39 of ash, and the dried leaves contained 17·84 per cent. of ash,—and on the 29th of September, the fresh leaves contained 88·66 per cent. of water and 1·95 of ash, and the dried leaves contained 16·31 per cent. of ash; that the per-centage of water in the lower part of the top is greater than in the upper, decreasing from 2 to 5 per cent. as we ascend; that the average quantity of water in the lowest part (90·22 per cent.) of the tops, is nearly 5 per cent. greater than in the highest part, (85·42 per cent.,) and 10 per cent. greater than the mean of the whole green part, including leaves and stalks; that the proportion of mineral matter in the tops increases with the age of the plant; that the average quantity of mineral matter in the green part of the turnip is greater by one fourth part in the highest than in the lowest part; that these averages for the green tops as they were gathered, are—for the highest part 2·19 per cent., for the lowest part 1·75 per cent., and for the whole top 1·98 per cent.; that in the tops dried at 212° Fahr. the proportion of mineral matter is greater in the lowest than in the highest part, by about one twelfth part,—the average for the lowest being 18·21 per cent., for the highest 16·84 per cent., and for the whole top 17·83 per cent. This difference between the relative proportions of mineral or inorganic matter in the upper and lower parts of the top in their green and dry states respectively, arises from the circumstance that the lower part contains also the largest per-centage of water.

The Uses of Turnips for Human Food.—The common culinary uses of garden turnip are so universally known that they do not require to be mentioned. The bulb of the Maltese golden turnip, which has an uniform orange colour, a perfectly spherical shape, and a fine flavour, is sometimes introduced with the dessert instead of fruit. The roots of the round black, round brown, long black, long brown, small Berlin, small long white, and Maltese long white turnips, are much esteemed on the Continent for their peculiar pungency. The bulbs of almost all garden turnips, particularly such as possess a comparatively high degree of the pleasant and characteristic acrimony of the brassica family, whenever cooked in any such simple way as to be easily digestible by a feeble stomach, are eminently serviceable to persons who have a tendency to scrofula, purpura, or any similar disease of the circulating system of the skin.

During a dearth in England in 1629 and 1630, 'very good, white, lasting, and wholesome bread, was made of boiled turnips, deprived of their moisture by pressure, and then kneaded with an equal quantity of wheaten flour.' The scarcity of corn in 1693, led the poor of Essex again to have recourse to this species of bread. It could not, we are told, be distinguished by the eye from a wheaten loaf; neither did the smell much betray it, especially when cold. During the recent famine in Ireland consequent on the failure of the potato crops, Swedish turnip was much recommended for cultivation by the peasantry and the small farmers, both as a general substitute for the potato, and as a special material for making cheap bread. One of the most common recipes of the day for converting it into bread was the following:—Take 8 lb. of Swedish turnips, peeled and weighed raw; put them down to boil in a metal pot, and when boiled strain and squeeze them well in a cloth, and pound them well in the pot; when pounded, squeeze them well again in the cloth, for the more you drive the contained water out of them, the less will the bread taste of the turnip; and then take 3 lb. of home-ground wheaten whole meal, or 4 lb. of such wheaten whole meal as is commonly sold by huxters, and work it up with the prepared turnips, and proceed with the dough in the same manner as with any other griddle bread. But a much more refined method than this, and at the same time scarcely if at all more costly, and applying fully as much to mangel wurzel as to Swedish turnip, was recommended, in the following terms, by the Professor of Chemistry to the Royal Dublin Society. "Neither the mangel wurzel nor Swedish turnip can be boiled without considerable loss of its nutritive matter, and if, after being boiled, the juice is pressed out of it, the loss is of course materially increased. By steaming these roots, there is much less loss of nutritive matter than by boiling them. I have tried a number of different methods of using these roots, but that which appears to me the best, and in which there is no loss of their nutritive matter, is the following:—First, wash and peel the mangel wurzel or turnip, then grate it, and either steam (in tin vessels without holes) or stew the grated pulp in a pot for half an hour, over a slow fire, occasionally stirring it. When it is dressed, use as much wheaten-meal as is necessary to make it into cakes without adding any water (which will be about its own weight, or a little more); bake either on a griddle or in an oven. The cakes thus made will be found very palatable and nutritious. They may be much improved by mixing through the flour a small quantity of carbonate of soda and tartaric acid

in powder, in the proportion of 30 grains of each to every pound of flour. The common muriatic acid of commerce being much cheaper, may be substituted for the tartaric acid, and thus used:—To 30 grains of the muriatic acid, add three times its bulk of water, and mix the diluted acid with the dressed pulp. The dry carbonate of soda is to be added to the flour, and the whole made into a cake. Common salt will be formed in the baking, and need not be put into the cake. The different kinds of meal, as from oats and barley as well as from wheat, will make good cakes with mangel-wurzel or turnip, without the addition of soda and acid. But the best, as might be expected, seem to be produced from the wheaten-meal. The cakes from mangel-wurzel, too, are generally considered as more palatable and better than those from the turnip."—*Dickson's Husbandry of the Ancients.—Reports to the Board of Agriculture.—Reports to the Royal Dublin Society.—Loudon's Works.—Miller's Gardener's Dictionary.—Museum Rusticum.—Society of Gentlemen's Complete Farmer—Arthur Young's Works.—Martin Doyle's Works.—Brown on Rural Affairs.—Transactions of the Yorkshire Agricultural Society.—Transactions of the Highland Society.—Irish Farmer's Magazine.—Irish Farmer's Journal.—Treatise on Vegetable Substances in Library of Entertaining Knowledge.—Philosophical Transactions.—Mills' Husbandry.—Dr. Dickson's Practical Agriculture.—General Report of Scotland.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.—Goodrich Smith's Economy of Farming.—Low's Elements of Agriculture.—Bayldon on Rents and Tillages.—Useful Knowledge Society's Farmer's Series.—Sproule's Treatise on Agriculture.—Lawson's Agriculturist's Manual.—Marshall's County Reports.*

TURNIP-CABBAGE. See TURNIP.

TURNIP-CHOPPER. See TURNIP-SLICER.

TURNIP-CUTTER. See TURNIP-SLICER.

TURNIP-FLY. Any insect which, in either its larva or its imago state, feeds upon any part of the turnip plant. The turnip-fly of most farmers, indeed, is especially or even exclusively the single species, *Haltica nemorum;* but that of some farmers and of most common country people is a whole and very heterogeneous group, and comprises all the beetles which feed on the seed-leaves, all the saw-flies which feed on the expanded root-leaves, and sometimes also the ants which feed on the seeds, the maggots and the wire-worms which feed on the roots, the weevils which cause excrescences on the bulbs, the aphides which desolate the foliage, and the moths and butterflies which infest various parts of the plant. Some of these enemies of the turnip are noticed in the articles SAW-FLIES, WIRE-WORM, BUTTERFLY, and APHIS; and some others, but chiefly the *Haltica nemorum*, will form the topic of the present article.

The genus haltica does not consist in any true sense of flies, but belongs to the cyclica family and chrysomela group of beetles; and it is characterised by having the antennæ slender, much shorter than the body, and eleven-jointed,—the head, as also the thorax, broader than long,—the thorax often with a transverse impression behind and the posterior angles obtuse,—and the tibiæ slender, with a simple spine on the posterior pair. All the species are readily known by the comparatively great thickness of their hinder thighs, and have the power of leaping, like fleas, to a comparatively prodigious distance; and take their generic name of haltica from this leaping power. The grove species, or turnip-fly par excellence, or turnip-flea, or turnip-flea beetle, or earth-flea beetle, or black-jack, *Haltica nemorum*, takes its botanical specific name from the circumstance of having principally frequented woods and groves before the period when turnip cultivation became general, but is now the universally diffused and desolating foe of the young turnip plant. Its eggs are very minute, oval, smooth, and somewhat of the colour of the turnip leaf; and its larva is fleshy, cylindrical, and pale, with six pectoral feet and a pro-leg at the apex,—the head furnished with jaws and large dark eyes, and the first and the last segments marked with dark patches. The perfect insect varies in length from $\frac{3}{4}$ of a line to nearly $1\frac{1}{2}$ line or one-eighth of an inch; and is generally larger and stouter in the case of the female than in that of the male. It is smooth, shining, and of a brassy black colour, with a slight tinge of green, particularly on the wing cases. The antennæ are black, with the second and third joints and the apex of the first of a pale colour. The thorax is convex above, and pretty deeply punctured. The wing cases, which are much wider than the thorax, are likewise thickly and irregularly punctured; and each of them has a pale yellow or slightly sulphur-coloured stripe, running along the middle, curved inwards posteriorly, and not reaching quite to the extremity. The under side of the body and thighs are black; and all the tibiæ and tarsi are of a pale hue. When the beetle is feeding, all the different parts of the mouth are employed; the upper and under lips open to liberate the other organs; the two sets of teeth, or the toothed mandibles, as they are named, meet when closed, and, from their strength and horizontal action, readily break the cuticle of the leaf. The jaws seem to be adapted for keeping in the food during the short process of mastication; and the four feelers hold and steady any portion of the leaf to be eaten, and assist in conducting the detached morsels into the mouth.

Several other and nearly allied kinds of haltica possess very similar habits to *Haltica nemorum*, and share in all its popular names, and present the same characters in a somewhat modified form; and they have received different names from entomologists, such as *H. flexuosa, H. sinuata, H. ochripes, H. intermedia,* and *H. parallela;* and

they differ from one another chiefly in the colour of the legs, and in the form of the longitudinal yellow stripe on the wing-cases. It is very unlikely that they are more than varieties of the same species; and however important it may be, in most other instances, to discriminate closely allied kinds of insects, this is of little consequence in the present instance, as all those mentioned, whether varieties or species, are alike prejudicial to the turnip, and are doubtless precisely similar in both their methods of mischief, and the modes in which they may be kept down or destroyed.

The *Haltica nemorum*, as well as each of the allied kinds, occasionally feeds on a variety of cruciferous plants; but, as already intimated, it is more particularly attached to the turnip, which it attacks both in its perfect and larva state. When the plants have acquired some degree of strength, and the foliage is considerably developed, the injury done is usually insignificant, as the partial consumption of the leaves does not interfere so materially with their functions, as to have the effect of diminishing the size of the bulb. In this respect the larva of the turnip saw-fly, *Athalia spinarum*, is incomparably more to be dreaded, as its greater size and voracity demand a much larger supply of material. But unfortunately the favourite food of the flea-beetle is the young plant, just as it is beginning to unfold the cotyledon leaves. These it consumes with the utmost avidity; and when it is abundant, it often, in a very short time, strips a whole field of its crop. It has, for so small a creature, a truly astonishing voracity; and has been observed, when shut up for the special examination of its habits, to consume no fewer than ten plants every day. The loss which it sometimes occasions, in years and districts favourable to its prolificity, is enormous; and so long ago as 1786, Mr. Young stated that the turnip-crop destroyed by it in Devonshire alone was valued at £100,000.

"The economy of this little pest," says Mr. Curtis, in a long and able paper, of which we shall here give an abstract, "has puzzled the man of science, as well as the practical agriculturist, for many years; and for want of that rigid care which is indispensable in the investigation of natural history, numerous errors have been adopted, which have led to the promulgation of many false theories. Dr. Pearson believed at first that the white spots or dots observable on more than half the turnip-seeds were the eggs of the turnip-fly; but he was compelled to abandon that opinion, having had no flies where the seed was sown in soil contained in pots covered with bell-glasses. Rusticus, however, a contributor to the Entomological Magazine, so strongly insisted upon it, that seeds steeped in brine, or otherwise prepared, have been sold in London at the seed-shops, to insure the grower against the attacks of the fly. It is exceedingly likely that the white dots are occasioned by minute flies alighting upon the seeds while they are drying, and depositing their excrement upon them, which is often white; or they may be particles of pollen from the flowers. It was, however, from the careful investigations of Mr. H. Le Keux that we were first made acquainted with the actual economy of this little beetle. If the spring be warm the sexes pair from April to September, during which period the eggs are deposited by the female on the underside of the rough leaves of the turnips. She lays apparently about one egg daily; and ten pairs laid in a week only forty-three eggs. This indeed was under confinement; but the correctness of this estimate is supported by the fact, that in leaves taken from the field, containing as many as six larvæ, they were all of different sizes, indicating a variety of ages. The eggs are hatched in ten days; and the little maggots immediately begin to eat through the lower skin of the leaf, and to form winding burrows by feeding on the pulp. These burrows are visible enough to the naked eye when the larvæ leave them, and the cuticles are withered and discoloured; but in their early stage, they are discovered with difficulty; indeed it is only by holding the leaf up to the light that they can be well detected. The larvæ are full fed in about sixteen days, when they desert their burrows and bury themselves not quite two inches below the surface of the earth, selecting a spot near to the bulb, where the turnip-leaves protect them from wet and drought. In the earth they become immoveable chrysalides, which are brought to maturity, I believe, in about a fortnight, when the beetle, or fly, as it is called, emerges from its tomb, again to fulfil the laws of nature. The beetles themselves are rather long-lived, for they have been kept in that state from July until the following February. Eighteen inches is about the greatest extent of their leap, which in a straight line, would be, averaging their stature, 216 times their own length; and when it is remembered that this leap is performed in a curved line, it must be admitted that a considerably greater distance is achieved. They seldom walk, and when at rest sit with their hind legs folded under them, ready to skip off in an instant, if disturbed, or when even approached. In warm weather, during sunshine, with the thermometer standing between 70° and 80° in the shade, they fly with facility.

"This little plague is not confined to our island, for it is abundant in Germany, and common everywhere in Sweden, where it is very destructive in its perfect state. Probably in England no portion of the country is perfectly free from these insects; at least every bank and meadow harbours them to a greater or less extent; and they have been found also on grass-lands which had not been ploughed for many years, and where there were no turnips within

half a mile. It will be necessary to consider this part of their history before we enter upon a discussion of the remedies. The turnip-beetles hybernate, or live through the winter, in a torpid state, and may be found under the bark of trees, as well as beneath the fallen leaves, in the chinks of old timber and paling, the stumps of thorns and of other bushes, where the bark does not adhere close to the stem; and the hollow stalks of grass and stubble seem to afford them an asylum during the inclement months of winter; but, inactive as they then are, the warmth of the hand is sufficient to revive them in a few minutes, so that an unusually mild day in January or March will partially seduce them from their retreats, and will render them almost as active as would the ardent sun of summer. On the first indication of spring, if the weather prove fine, warmed by the sun and cheered by his rays, they arouse from their slumbers, and permanently leave their winter quarters for sunny situations, where they may be seen sitting on walls in considerable numbers, or sunning themselves on dry banks and on clods of earth, protected from the wind. They have been observed in gardens on turnips and cabbage-plants as early as March, and in April on the crops in the fields; but May and June appear to be the more usual periods of their first and most fatal attacks. The autumnal crops have been occasionally destroyed by them, and in one instance I have seen recorded, as late as the middle of September. They may be said to be abundant from May to October amongst the grass, and in all fields, whether of wheat, oats, or barley. It seems that the taste of the turnip-beetle is far less fastidious than is generally imagined. This might be fairly inferred from its abounding in situations where the turnip does not grow. There can be little doubt, however, that it prefers those plants which are termed cruciferous, from the shape of their flowers, of which cabbages and turnips are examples; of these the leaves of the horse-radish, the common turnip, and the radish are its favourite food, but cabbages, cauliflowers, colewort, watercresses, ladies'-smocks, and hedge-mustard called jack-by-the-hedge, are often attacked; the charlock or wild mustard is also sometimes covered with them at the end of April, and in May the leaves will be seen pierced with holes, but as soon as the turnips come up they desert other allied plants. Mr. Berry has recorded a remarkable exception, for he says that, after consuming the cabbage-plants, the flies attacked and destroyed the young hops, which belong to a very different tribe of plants. Köllar also states that both summer and winter turnips left for seed suffer in warm and dry weather, from the attacks of the fly injuring the flowers so as to spoil the produce of the seed.

"The next subject to be considered is a remedy against the attacks of the turnip-beetle. Now with regard to the eggs, we see that they are laid on the under side of the rough leaf, where they are pretty well secured from rain, and also protected by the strong and projecting ribs that support the leaf from any injury that might occur from the leaves being ruffled by the wind or other casualties; and the inferior skin, being the most delicate, is best adapted for the entry of the infant and tender maggots into the substance of the leaf. It is not, therefore, at this stage that much could be done in destroying them. The maggots, it is evident, live upon the rough leaf, and do little or no mischief to the growth of the plants; they dwell perfectly secure between the two cuticles, unless it be when they leave the burrows they had first commenced, probably not of common occurrence, to form new ones at a remote part of the same or upon another leaf. At this period they are most probably affected by parasitic enemies. The chrysalis is buried only just beneath the surface of the earth, but it is probably protected in a slight web, forming a cradle for it to lie in free from pressure. I think some efforts might be successfully made for its destruction at this time. It is, however, in its last and perfect state that the mischief is done. It is the beetle which destroys the two first smooth leaves, called the cotyledons, and the heart of the plant between them, by piercing them like a sieve, destroying the cellular tissue and stopping the growth of the plant. They also feed upon the rough leaves, drilling them full of round holes, which are larger on the upper than the under side of the leaf; and if the appetite of the beetle be not satisfied, he enlarges the aperture and thus gives it an irregular form, which dilates with the growth of the leaf: hence the large holes we see at a later period. After all, it is at this stage of their existence, I am inclined to believe, that we can attack them with the best prospect of success, if they cannot be kept off by other means. In collecting the turnip-beetles by sweeping and various methods, large numbers of small carnivorous beetles, belonging to the *Carabidæ* and *Staphylinidæ*, are found with them. These probably feed upon the larvæ; but from the very recent discovery of the early stages of the turnip-beetle, we are yet ignorant of the parasites, of which it may be presumed there are more than one species, that prey upon the maggots and chrysalides; for it is a wise dispensation of Providence to keep every animal in check by some other that is either more powerful or more sagacious than itself; and this counteracting effect is produced in a degree equal, or eventually superior, to the noxious animal, so that in a greater or less space of time the destructive power may be rendered no longer formidable, or be absolutely annihilated by the attacks of its parasites. This natural process, though never failing, is often too slow in its operation to secure immediate relief. The farmer must, therefore, devise means, if possible,

for the more speedy destruction of the enemy. The beetles are seldom found in shady places, except during the winter season, and they cannot bear cold and wet, which are great protections against their increase; it consequently follows that warmth and sunshine are far more favourable to their multiplication, and in such seasons they are most to be dreaded. Showery weather, after a long drought, and cloudy days with gleams of sunshine, also render them abundant, as such seasons do the greater portion of insects; but in a few instances they have been known to do much mischief even in cold weather. That the turnip-beetle is endowed with an acute and powerful sense of smelling is proved by his flying against the wind, and deserting all other plants as soon as a turnip-crop appears in his neighbourhood. Mr. Le Keux says that in May 1836, when the thermometer was at 75° in the shade, during a south wind, great numbers were on the wing, and all proceeding southward; and again, that eight acres, forming the summit of a hill in Devonshire, were sown with turnips, and when the young plants were just rising above the ground, the wind being for more than a week at south-east, wafting the scent to the north-west, they were so destroyed on this side, that nearly an acre was bare, whilst the south-east side was not touched until the plants had attained a size to render the attacks of the beetle of little consequence. From what has been stated, it appears that no season will secure us entirely against the attacks of the turnip-beetle; and that no soil is considered safe from them is evident upon the best testimony; it is very destructive upon strong lands, and not less so on light ones. Neither is the period of their attack limited; for, as one pair of insects may produce five or six broods in a season, there is a constant succession, which renders any plan for extirpating the beetle in any of its three early stages scarcely practicable.

"As the turnip when in rough leaf is not in any danger from the attacks of the beetle, it is evident that our first care must be to preserve the young plant; and this can only be done by the preparation of the soil, or using such speedy means the instant the beetles appear as will destroy or drive them away. The primary object will be to discover the best manure for that purpose, and a dressing that will render, if possible, the soil obnoxious to the insect. It has been correctly said 'that the manure which most effectually promotes the growth of the plant will be the best defence from the insect; and that, when the growth is slowest, the danger from the insect is most serious.' This arises in a great measure from the advantage that insects have over vegetation. A gleam of sunshine is almost sufficient to call them into active life, as we have before observed, and as is evident from the swarms of delicate gnats that may often be seen dancing in the air when frost is on the ground even in January; but it requires the accumulated rays of the sun, and a much longer duration of warmth, to set in action the fluids of plants. Whether any direct protection against the beetle can be expected from manure, since it is ascertained that it is not upon the seeds that the eggs are laid, now becomes a question; for when the maggots escape from their burrows in the leaves, and enter the earth, in order to become chrysalides, before changing to beetles, the manure, I should think, seldom contains sufficient ammonia to destroy them,—and, if I mistake not, any moderate fermentation would rather facilitate than retard their metamorphoses. Moreover, the instinct of insects is so perfect, that the maggot would most assuredly avoid obnoxious spots, so that, if any manure were spread that would injure them, unless it formed a very uniform stratum, it would not insure success, although great advantages might be derived from its use.—Burning has been found the best preventive against the beetle by some, which is readily accounted for, since it would destroy any chrysalides in the land; and as the beetles may be in abundance in the field when it is preparing for turnips, burning would, of course, be destruction to them,—and spreading the ashes afterwards over the ground will prove an additional security. But such a system does not suit sandy soils, neither can it be followed up regularly on any land.—Feeding off the turnips is strongly recommended as an antidote to the beetle, as well as from its peculiar advantages of manuring and preparing the land for the barley-crop and succeeding seeds. I am disposed to attribute the advantages derived from sheep-folding, as regards the beetle, to the perfect stamping down of the soil and herbage, by which all insect life is destroyed, rather than to any peculiar quality in sheep-manure, unless it be contained in their urine.—It is the opinion of a great many agriculturists that raw and long manure harbours the beetle; and if turnips be sown on a stubble-crop they are often completely destroyed. I see Mr. Webb Hall states that he has had to sow stubble-crops three times over; and seed sown on stubble late in August has been taken off by the beetle in more than one instance. Whether this arises from the hollow straws affording a retreat for the beetles, or that the weeds had supported them or the maggots, so that the chrysalides were lying undisturbed in the land, is not easily explained.—Mr. Linton and many others recommend drilling-in, not less than three or even four pounds of seed to the acre, and six or seven pounds broadcast; for he very justly observes that thick sowing causes the plants to grow much more rapidly when young than thin sowing; and by drilling in with the seed a peculiar compost, containing the strongest animal manures, the fly, he says, has never yet disappointed him of obtaining a good crop. I think it probable that the ammonia in this po-

tent manure may be disagreeable, if not destructive, to the insect; and the rapid growth of the plant, from its stimulating effects, defies their attacks. The vegetation of the seed may be accelerated by steeping it in water for twenty-four hours; and the surest way to obtain a strong crop is to sow seed of the same age, otherwise the plants do not come up simultaneously, and the fly will attack and destroy the crop in detail. Mr. Linton also adds that he has found more benefit from the manure he describes in the succeeding crops of clover-seeds than from three or four chaldrons of lime to the acre. With regard to the use of lime, a great deal must depend upon the soil on which it is used, which may account for the conflicting opinions respecting its effects in protecting the turnips against the fly. From six to eight bushels of quicklime per acre may be sown over the young plants successfully in dry weather; but it must be repeated after rain or dew; and this, as well as soot, requires to be regularly and evenly dusted over the plants. Mr. Birk says that he used slaked lime with perfect success; and although profusely, it did not at all injure the plants. It should be slaked at the time of use, and ought to be spread in the very hot state, when it burns the fly. Some danger to the plant seems to attend this process, arising from the heat generated by the lime; at least so I presume; but some little explanation is required in these statements to distinguish clearly between slaked and quick or unslaked lime. Very different were the results from Mr. Le Keux's experiments. Forty bushels of lime per acre were spread, he says, immediately before the seeds were sown, and did no good; and when the plants came up, and the fly was observed attacking them, lime-dust was thrown over them, so that many of the plants were quite white with a coat of it; after which as many flies were found upon those as upon any that were free, and they were eventually devoured. This is again quite at variance with the opinion that repeated dustings of ashes and soot, when the plants are wet with dew, will keep off the fly, and prevent their feeding. In another place he states that the upper part of a field in a sheltered situation, with a south aspect, which had been sown with barley, was well dressed with lime, and sown early in May with white stone turnips, which were destroyed as soon as they appeared above ground; the land was sown again, and harrowed, the surface being thickly strewed over with wood-ashes; the plants were, however, devoured as rapidly as before.—The growth of the turnips being stunted by too frequent repetitions, they become fingery on light sandy soils, and are then more likely to fall a sacrifice to the fly. A good coat of clay or chalk has the effect in Norfolk and Suffolk of invigorating the land, and giving it the power of again producing good crops once in four years. The culture of mangold-wurtzel is well deserving the attention of the farmer, when the land gets tired of turnips; and it has the additional recommendation of not encouraging the increase of the turnip-beetles. As it is quite certain, I should say, that the beetles are attracted by scent, it appears to me likely that, if a field of turnips were planted round with a belt of mangold-wurtzel, the turnips might escape their attacks, if not entirely, to a very considerable extent; especially when the insects are believed to come from a distance; for at the early stage of the plants, a few hours of respite may be of vital importance. The Swedish turnip, or ruta-baga, whether it be a hybrid produced by the turnip and cabbage, or a distinct species, has not the strong scent at an advanced period which is so perceptible in the English turnip when in rough leaf; and if there be as marked a difference of smell in the seed-leaves, it would give the former a decided advantage in exposed situations, where the beetles are attracted from distant localities. Being sown in May or June, however, is, I conceive, not a recommendation, as I believe that to be a period of the year when the first principal brood is generally at its maximum, as the second is in August or September; but the temperature of the seasons may in this respect make a variation of a fortnight or three weeks on either side of the average. However this may be, it is admitted on all sides that the beetle is weakest in July. I fear, on the other hand, that no early sowing can insure the turnip-crop; for as the beetles hybernate, the same warmth and sunshine that make the seed vegetate will bring the swarms of beetles from their retreats; and it is worth considering whether by early sowing we do not entice a hungry horde from their winter quarters, or from the banks and meadows where they are first supported; whereas by not sowing until midsummer the beetles may in the mean while be starved and drawn off to more favourable localities, or have fallen a sacrifice to small birds and the casualties of the wet and cold of our spring. Such seasons we know do not agree with the beetles; and I have observed that, when the dew is upon the turnips in the autumn, they keep under the leaves, and appear to be asleep; and windy weather has a similar effect in rendering them quiescent. The crops being attacked and destroyed in the autumn does not altogether militate against good success at midsummer, especially in forward seasons. Similar objections to the above may be urged against sowing the white turnips with the swedes; for if the quantity of beetles be small, the swedes may be preserved in consequence of the turnip being their favourite food; but, on the other hand, multitudes may sometimes be thus attracted from a distance, which would not otherwise, it may be presumed, have detected the swedes, from their scent being less perceptible.—Some benefit might be derived from destroying those cruciferous plants *Erysi-*

mum alliaria and *Cardamine pratensis*, to which these *Alticæ* are so strongly attached, for they grow in abundance in every hedge and meadow; they appear long before the turnips come up, and attract and give support to the parents of the future swarms that are to sweep away the crops of the farmer. As these plants often flower at the beginning of April, and produce their leaves at a much earlier period, it is almost certain that they nurse the fly, and are its great resources for food and nourishment in the earliest days of spring. But how to eradicate the *Cardamine* is for future consideration. The hedge-mustard, and other cruciferous plants on banks and road-sides, are quite under our control; and it is a duty which we owe to our neighbour as well as to ourselves to keep our fields and hedges clear of charlock and every allied weed of that family, all of which harbour the turnip-beetle.—Before dismissing this portion of the subject two or three remarks will be useful. It is certain that manure gives strength to the turnip-plant, but it is doubtful if it will destroy the beetles. Hoeing and rolling may harass and kill many of them; and as this process promotes the more rapid growth of the plants, it must be attended with no slight advantages. I expect also that, if it were performed in damp days, or after heavy dews, the benefit would be increased; for if the beetles leap in moist weather they often fall upon their backs, where they stick, and after being exhausted become torpid and apparently dead, if the air be cold; but they reanimate as they are dried by the sun. In cold and wet weather it might not prove less efficient; for multitudes of the flies are then sheltered under and about the clods, which being broken down, the insects must perish by the pressure; and if there were any chrysalides in the earth, they would in all probability suffer the same fate.—There are many who consider that turnips should be sown immediately after ploughing, and that much of the success attending a crop depends upon the diligence employed in getting in the manure and seed; whilst some maintain that the land should lie undisturbed for a fortnight before sowing. Such conflicting opinions, as far as the fly is concerned, may often be reconciled by the difference of the seasons when the observations were made. We know that turnips must not be sown in too dry nor too wet a state of the soil, yet this is precisely the state most fitted for the production of the fly; for it is well ascertained that a moderate degree of moisture is necessary to bring forth or to hatch almost all insects,—and if this be accompanied by a mild air it is the better suited to them. It is therefore reasonable to expect that after a fine early spring the turnip-beetles will be found most abundant.—From the dislike the fly has to repeated wet, I have always thought that watering the turnips would be highly useful; and this opinion is supported by Mr. Bayldon, who recommends them to be watered every other day, four, five, and six times, if necessary. Irrigating the land would not have so good an effect, I think, as watering, because the beetles would only be floated off the leaves if they were detached at all; and if they were left thus for two or three days, there would be a great chance of their recovering when the plants were left dry; whereas by the watering they would be forcibly brushed off, and get set fast in the earth and die. The benefit would be most felt, I conceive, on heavy lands, with regard to the annihilation of the beetles; but it would everywhere have the advantage of destroying the chrysalis, by stopping up the pores of the soil, and so preventing the exit of the fly.—Nitrate of soda has been tried in two instances on crops of Swedish turnips with very beneficial effects; and it probably assists, from its peculiar qualities, in checking the increase of the beetles. The nitrate was sown two or three days after the seed; and it may be used on all soils excepting on chalk. It should be sown broadcast, mixed with wood-ashes, which enable the sower to spread it more regularly.

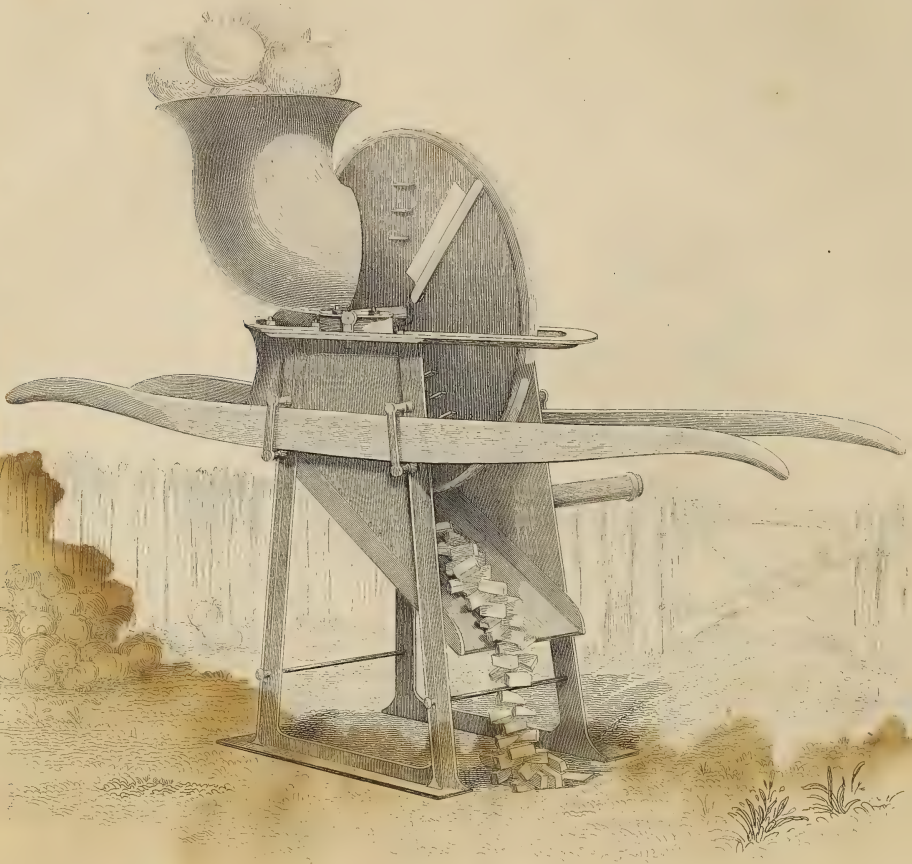
"We now come to what may be termed direct remedies. The Paul-net, as it is called, after its inventor, although it has been considered as a toy, yet I am of opinion might be usefully employed; for I have seen a quart bottle filled with the little turnip-beetles that were all caught with this net. If I remember correctly, Mr. Paul's plan was to sow a small spot with white turnips early, as a decoy, and over that space to draw his net. It always struck me that vast quantities made their escape by skipping out of the net, which was its greatest defect; but this might be remedied by placing some sawdust at the extremity of the bag, mixed with lumps of common ammonia, or sprinkled with spirits of turpentine, which perhaps would be better; but either of these would kill a great many, and stupify the remainder, until the contents of the net were subjected to sufficient heat to deprive them of life. This process is no doubt troublesome, and requires to be repeated; and unless, perhaps, some alterations were made, it would not answer on an extensive scale. This, however, is no fatal objection to the principle.—A board newly painted or tarred, and drawn over the turnips will catch multitudes of the beetles; for on being disturbed they leap against it, and cannot release themselves. I should recommend white paint; and the brighter it is the better, as all insects are attracted by light colours. Neither wet nor windy weather would be suited to these operations; for it is ascertained that the beetles are at such seasons disinclined to move; neither would mid-day in fine weather do, as they are then active, and fly well; for it is a well-known fact, corroborated also by the flight of swallows, that in hot days and sunshine insects fly high, whilst in damp weather they keep upon or near

the ground.—Fumigation by burning stubble, weeds, &c., to windward of the field, so that the smoke drives along the ground, has proved effectual; but I should prefer burning to leeward as a preventive, for as the beetles are attracted by the scent of the turnips, and fly towards the wind, they would be baffled by such a manœuvre. —Watering the plants with brine sufficiently strong to affect the insects, but not strong enough to injure the young plants, would, I expect, prove a most successful remedy; and when in rough leaf it would also kill the larvæ, and even destroy the eggs that were exposed to its influence.—In Hanover, fields of white turnips have been preserved from the fly by thickly sprinkling the dust of chalky roads on the young plants at night, when a heavy dew is falling, until they appeared covered with the powder. The fly, it is said, will at once disappear, especially if the next day be a bright sunshine, and the dust is dried upon the leaves, which prevents their little teeth from gnawing the leaf, or disgusts them in some other way, and they depart to more agreeable quarters. If the sprinkling be immediately succeeded by heavy rains, so that the dust is washed off, the operation must be repeated. Several other means are suggested by M. Wundram, which have proved to be useless in this country; and his reasoning induces a belief that he is not well acquainted with the habits of the turnip-fly. An infusion of wormwood sprinkled over the young plants and seed-beds will, he says, secure them from the attacks of the flies, as they dislike the bitterness thus conveyed.—Drawing boughs of the elder over the field is supposed to annoy the beetles, and drive them away; and the leaves of the alder, when fresh gathered, being covered with a glutinous liquor, and those of the lime, &c., when the honey-dew is upon them, are recommended to be strewed in gardens for the purpose of catching the turnip-beetles.—I confess that I have no faith in the plants being rendered obnoxious to the fly from steeping the seeds in oil, brine, brimstone, or milk, as practised by many. Such immersions may render the plants stronger, or cause more of the seeds to vegetate, which will at once account for the success that is said to be derived from this process. If, indeed, the eggs of the insect were laid upon the seed, the oil and brine would be most efficacious; but that notion is exploded. —Mr. Le Keux says that washing over the plants with sulphate of potash had no effect; and he very justly observes that, if the upper surface of the leaf could be poisoned, the beetles might feed upon the under side with impunity. Powdered sulphur, strewed one-tenth of an inch thick, did not deter the flies from attacking the plants, but it improved their appearance. Snuff, asafœtida, a powder called anti-tinea, for preserving furs, proved equally powerless. They did retire from carbonate of ammonia, and died immediately on being exposed to the effluvia from it; but a small bit placed an inch from the plant would destroy it also. This, or something that would overpower the scent of the turnips, might perhaps be advantageously employed in driving away or deceiving the fly. One ounce of tar, one ounce of olive-oil, and two ounces of strong caustic potash, well mixed together, and shaken up with the requisite quantity of water, were next poured, the fourth day after sowing, over a patch on a hill swarming with the fly, at the end of August. Not many of the seeds came up, but the few plants from them were of a healthy colour, and acquired the rough leaf, a few only on the windward side being punctured; but several days' rain occurred at the most critical time, which might be their best protection.

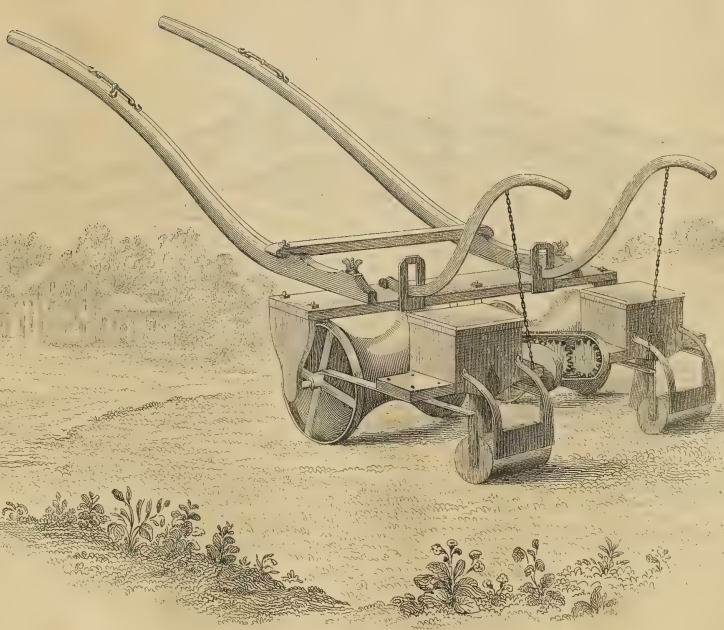
"Such are the remedies proposed; but I fear it is not by the experiments of a few philosophic men that we can hope to discover any positive antidote to so great an evil. We want correct data from every sort of soil under the various influences of climate and effects of cultivation, before we can fairly grasp the subject. Until we became acquainted with the economy of the beetle, we were groping in the dark. That important discovery has brought us a few steps towards the light; and those who wish to follow in the path of truth should try and examine Mr. Le Keux's experiments, which it is easy to do by filling a garden-pot with earth, carefully sifted to take out all worms, centipedes, or other living animals, which might destroy the chrysalides. When this is done, plant in it a small turnip, in rough leaf, having a fine wire-gauze guard, large enough to enclose the plant, and fitting just inside the top of the pot. One or more pairs of the beetles must be placed, with a fresh turnip leaf, in a large-mouthed transparent bottle, then tie over the end a piece of muslin, to prevent the escape of the insects; for if the cork or stopper be put in, the bottle will become wet inside, which will prevent the females from laying any eggs. I imagine they will not adhere to the damp leaf. The leaf may be examined daily through a magnifying-glass; and as soon as any eggs are discovered, they may be placed in the pot where the turnip is growing, that the little maggots may be able to get at the living leaves as soon as they hatch. The progress of the insect may thus be traced through its different stages; and it will only be necessary to place the garden-pot in a saucer, into which water should be daily poured, if necessary, to nourish and refresh the plant.—Let us not forget that amongst our best friends are the small birds, a great number of which, such as the grey and yellow wagtails, no doubt destroy incredible numbers of these insects in their various stages. Their nests ought to be protected, and the birds themselves defended from persecution."

Two small beetles of the curculio or weevil family often make considerable havoc upon turnips when in flower and seed, and have thence

Bairds Turnip Slicer.



Geddes' Turnip-Sowing Machine.



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obtained the name of turnip-seed weevils; and one of the two also destroys young turnips by puncturing the leaves, and has occasionally been found almost as mischievous as the *Haltica nemorum*. This latter, called *Curculio contractus* or *Ceutorhynchus contractus*, makes its attacks on the leaves in its imago state; and is from $\frac{3}{4}$ of a line to 1 line long, and of a black colour, with a coppery tinge,—the head and thorax coarsely punctured,—and the elytra generally green, sometimes inclining to blue, and rarely blackish. The other, called *Curculio obstrictus* or *Ceutorhynchus assimilis*, is similar in appearance, but about twice as long; and both make their devastations upon the seed-pods and the seeds in their maggot state. Both also, in their imago state, are so sensitive that they fall down, if only approached suddenly, from the flowers or leaves on which they are feeding; and may be easily collected, when they abound in the turnip-flowers left for seed, by shaking the stalks over a large net or cloth. But as they immediately unfold their legs and begin to run away after the shock is over, the contents thus collected must be swept into a pail of lime and water or urine until they can be removed and destroyed by pouring boiling water over them; for as their horny jackets are very hard, they are not easily killed by being merely trampled on or beaten.

TURNIP SAW-FLY. See Saw-Flies.

TURNIP-SEED FLY. See Turnip Fly.

TURNIP-SLICER. An implement for cutting turnips into pieces, for the use of sheep and cattle. It is very widely various in structure; and comprises the three kinds of form,—the turnip-chopper, the turnip-slicer proper, and the turnip cutting cart; and each of the two latter kinds also comprises widely different varieties.

The turnip-chopper consists of a handle and two iron blades resembling common garden hoes,—the blades placed perpendicularly upon the end of the handle, and at a right angle to each other, so as to form a cross; and, by a single stroke upon a turnip bulb, lying either where it grew or elsewhere on the ground or in a trough, it cuts the bulb into four parts; and may, when necessary, be used to subdivide any or each of them into four other parts. It is an efficient tool in the hand of an expert man; but, when the quantity of turnips to be cut is large, it requires great strength of arm for maintaining the prolonged exertion. An old variety of it has on the reverse end of the handle a two-pronged fork for giving additional weight to the stroke, and for picking entangled or deep-seated roots out of the ground. But a separate implement, bearing the name of a turnip-picker, is now commonly used for the latter purpose; and is sometimes so modified, with a curved blade instead of a fork for its head, as to be serviceable for either chopping away the body of the bulb from the tap-root, or picking out the shell or bottom of an eaten bulb. The turnip-chopper, in any of its varieties, is better suited for the field than for the farm-yard; and cuts the turnip-bulb into a form of section which is found very manageable for the mouth of most sheep and cattle.

The revolving turnip-slicer, is one of the best of its old forms; and in a shape which serves as the type or groundwork of some of the best improved varieties of the present day, consists principally of a hopper and a fly-wheel or disc set upon a standard or frame. "The area of the fly-wheel is covered with wood; and there are two cutting-knives, each nearly the length between the rim and the centre, placed in it at equal distances from each other, that is, one on each side of the centre, straight in a line dividing the circle into two semicircles. The hopper is placed up in such a position as that the turnips put into it shall always at its under side press against the side of the wheel. This under mouth of the hopper is made of the same breadth as the length of the cutting-knives, that is, somewhat less than the radius of the wheel. The wheel is made to revolve, so as that the knives shall cut when passing down by the under mouth of the hopper. At the face of each cutting knife there is a space left, by which the slice cut off falls down at the opposite side of the wheel to that at which the hopper is attached; and by every revolution of the fly-wheel, each of the knives passes the hopper and cuts a slice off all the turnips which are at the time passing against the wheel." A variety of this implement, invented by Mr. Baird of Shotts, has a circular cast-iron plate instead of the wooden disc, and is provided with transverse cutters for dissecting each slice of turnip into smaller pieces, and, with the exception of the knives and cutters, is made entirely of cast-iron. The plate is cast a broad rim or thickened edge which gives it, when in motion, the centrifugal power of a true fly-wheel; the thickness of the slices is regulated by the distance of the knives from the face of the plate; and each knife is preceded by three or more lancet-pointed studs which by slitting the turnips in passing, prepare the slices for falling in pieces when they are detached from the knives at each revolution of the plate.—Most of the recent and improved revolving disced turnip-slicers, as well as Mr. Baird's, are provided with a contrivance for dissecting the slices into pieces; and many have this contrivance in the form of small knives, standing crosswise before the edge of the slicing knife, and fixed upon a small plate which may be inserted or removed at pleasure; so that when this plate is absent the turnips are cut merely into slices,—and when it is present, they are dissected also into small pieces. Some of the machines, likewise, are mounted on mere quadrupedal frames, while others are mounted on wheelbarrow-formed frames; and the latter are convenient either for travelling along a field, or for depositing supplies of the sliced turnips in a series of troughs.—Mere slices are sufficiently

manageable in farm-yard feeding for cattle, but are liable in the field to be rubbed on the ground and besmeared with mud before they can be mastered; and sections of slices, about 1¼ inch broad, ¾ of an inch thick, and of the length of the diameter of the turnip, are, in all circumstances, very convenient for sheep.

The cylindrical turnip-slicer, or Gardner's patent turnip-cutter, was invented by Mr. Gardner of Banbury; and is generally acknowledged to be the best implement of its class at present in use. It has become very extensively diffused in England; and is so well known to the majority of large English farmers, as scarcely to require any description. It comprises a hopper, a cylinder, and a receiving box,—the first mounted above the second, the second above the third, all adjusted upon a simple quadrupedal frame; the cylinder revolves upon an axis resting immediately on the frame, and is armed with knives for cutting the turnips into small pieces for sheep; and the knives have cutting edges at right angles, and are placed accordingly above one another from the margin inward till they form a junction at the centre.

The lever turnip-slicer is a reciprocating machine, and has, at the end of a trough or hopper, a case of cutters of a gridiron shape, so commanded by a fixed lever handle as to cut the turnips into oblong pieces. The person who uses this implement works the lever handle with his right hand, and presses forward the turnips with his left; and he may either hold untopped turnips by the tops during the operation, or push forward topped ones with a small fork, or a sharp-pointed stick, or a kind of wooden trowel.

The improved lever turnip-slicer, or Wallace's turnip-slicer, differs materially in construction from the preceding, and was invented by Mr. John Wallace of Kirkconnell in Kirkcudbrightshire. "It consists of a stock, 2 feet 10 inches long, and about 6 inches broad, formed of two pieces of hard wood connected by an iron bar, which is repeated on the opposite edge, and the whole bolted together. The two pieces forming the stock being withdrawn from each other so far as to leave a rectangular opening bounded on the two ends by the pieces of the stock, and on the two sides by the iron bars, which, to the extent of the opening, are thinned off to a sharp edge, and thus form the two exterior cutters. The stock is supported at a height of 2 feet upon four legs. Two cutter blocks are appended to the stock by mortice and tenon at the respective ends of the opening, and are further secured by the bolts of the side bars. Into these blocks the remaining cutters are inserted in corresponding pairs, and also secured by bolts. The cutters thus arranged, form a cradle-shaped receptacle, into which the turnip is laid to be sliced; and a lever is jointed on a bolt at one end of the stock and armed over the receptacle with a block, which is stretched on its lower face with iron knobs, and which fits loosely into the receptacle." In operating with this machine, the workman takes hold of the lever with the right hand, and, having raised it sufficiently high, throws a turnip into the receptacle with the left; and when he brings down the lever, the knobs prevent the turnip from sliding backward or forward, and the force of the pressure pushes the turnip against the edge of the cutters, and separates it into slices by one stroke.

The turnip-cutting-cart is simply an ingenious adaptation of the revolving disc turnip-slicer to any common turnip cart; and affords a very convenient mode of feeding sheep on pastures or lawns. Two good varieties of it are in use,—the one invented by Arthur Biddell of Rayford, the inventor of the well-known scarifier which bears his name, and the other invented by James Kirkwood of Tranent. The large cog-wheel of the slicer, in Biddell's, is attached to the back part of the nave of the cart-wheel; an upright lever, moving in a fulcrum-bolt in the cart sill, brings the small cog-wheel into gear with the large cog-wheel on the nave; a small wedge at the top of the lever, passing through the rail of the cart, keeps the cog-wheels either in gear, when the slicer is worked, or out of gear when not required to be turned by the horse; the axle of the smaller cog-wheel, passing through the end of the upright lever which is its only wear at that end, goes under the cart and half-way across, where, at a right angle, it meets, and, by a small pair of bevil-wheels, is connected with the axle of the slicing-wheel, with its two knives; and when this slicing-wheel is put in motion, by the base moving forward, and the cog-wheels being put into gear, it turns with great velocity, and the turnips roll to the knives from a sloping false bottom; and when the cart is wanted for common agricultural purposes, this false bottom and the slicing-wheel are temporarily removed.—The machine, in Kirkwood's invention, is attached by means of a chain to the hind part of a cart loaded with turnips; and when the cart is drawn forward, the machine rolls upon its own wheels, and derives motion from them to its slicing-wheel and feeding roller; and a boy or a man sits in the cart and pitches the turnips into the hopper;—and when the machine is detached from the cart, and has a winch-handle applied to its cutter-wheel shaft, it is converted into a perfectly efficient hand turnip-slicer.

Several of the chief advantages of turnip-slicing, either in folding sheep on the turnips or in supplying them with them in other fields, may here be profitably stated.—1. The most obvious, though perhaps not eventually the most valuable, has reference to the sheep's teeth. Pulling and tearing at the turnip loosens the two front cutting teeth of the hoggs and old sheep to such an extent, that they are apt to fall out, and, in many cases, actually do so. In this deficient state of the mouth, it is impossible that the younger animals

can eat a hard Swede turnip, and in such a quantity as quickly to fatten and be ready for the market. Indeed, if the turnips be not cut, many of the flock can scarcely exist, and, while in the midst of plenty, may be actually starving. The teeth of the more aged sheep, again, from a variety of accidents and diseases to which they are liable, and from having been also much worn down by the hardness of many plants on which they have subsisted, are often, before they are put on the turnips, in a very imperfect condition, which necessarily prevents them from rapidly taking on fat, when folded on turnips, according to the old way. The malformation, also, in the structure of the upper jaw of some varieties of sheep, known in Scotland by the name of *grun-mouthed*, is another reason to adopt the plan of feeding sheep, when folded on turnips, with these roots cut into thin, narrow slices.—2. The hoggs and the older sheep, when placed on turnips, will feed much quicker and be kept in a more healthy condition, when these roots are cut with machines into small, narrow slices, which they can easily take into their mouths, and which are placed before them in long wooden troughs within the fold; and they will sooner fill themselves, and lie down, and ruminate. It is certain that the less time is taken up in eating, the more speedily will the animal become fat; and that the quicker that flesh can be laid on, the greater economy will there be of food. By treating the young sheep or hoggs in this way, at about a year old most of them may be sent from the turnip field to market fit for the butcher. This is a very great benefit to the farmer, not only enabling him to increase the number of his sheep, but also better to prepare his fields for growing his grain crops.—3. Another signal advantage in this management of turnips, is that if any part of the field be poorer in its soil than other parts, it may be made equally rich and productive in bearing crops of grain and grass with the richer portions of the land. In feeding the sheep with cut turnips, they may be made to stand, as long as it is wished, on any particular part; and by judiciously removing the troughs to different parts within the fold, the manure may be equally well distributed all over it. There can be no more effectual plan than this of improving poor, sandy, gravelly soils. The flock, confined within the fold, tread and render the earth more compact and retentive of moisture; and by their droppings, urine, and perhaps perspirable matters exuded from the fleeces while lying on the ground, make it fitter to yield heavier and richer crops of grass and grain.—4. The carcass of the sheep is not the only part of the animal which is improved by this method of feeding; but the wool also is produced in greater quantity, and of better quality. The more improved higher condition of the sheep, influences the quantity and quality of the fleece. "It ought never to be forgotten, that the growth of the wool is liable to be materially affected by the system of feeding pursued. It is essential to the evenness and strength of the staple, that the feeding of the animal should be uniform, without any sudden interruption or transition. Where this is suffered to take place, the natural progress of the wool is for a while most injuriously interfered with. It continues to grow, but the new fibre is unhealthy, and becomes so weak as to snap under the operations of the manufacturer. Much wool is injured in this way by the change between summer and winter keep; and sudden transition from rich to poor, and from poor to rich feeding, ought most carefully to be avoided."—5. Another advantage resulting from this mode of feeding, is that there is a much smaller waste of turnip,—that we have it in our power to give the animals just what kind and quantity of food we may think proper,—that these useful roots, the farmer's chief dependence for the winter keep of his woolly stock, may be preserved to a late season of the year, when provender is most in demand for them. It is the opinion of good judges, that the slicing of turnips, and putting them into wooden troughs to be eaten by the flock, makes these roots go farther by one-fourth than in the old way of feeding. Every part of the root is rendered eatable. To make the turnip, therefore, go as far as possible in feeding stock of all kinds, whether in the stall, the farm-yard, or the sheepfold in the turnip field, let no farmer be without the useful turnip-cutting machine.—6. Wherever an experiment has been made to fold upon a turnip field two lots of sheep, equal in all respects as to age and condition, putting at Martinmas the one lot into one fold, the other into another, and continuing to feed regularly the two lots,—shifting at stated times the fold to fresh portions of the field, the one lot to be fed in the usual way on the turnips, together with supplies of oil-cake, salt, and cut hay and straw, but the other to have the turnips cut into thin narrow slices, and placed in troughs before the sheep,—it will be found that the lot which has had the turnips supplied to them cut by the machine, with the oil-cake, salt, and cut hay and straw, will be as forward in the middle of February, as the former lot would be in April. But, should the two lots be kept feeding for twenty weeks, the lot which has had the turnips supplied cut into thin narrow slices, will fetch from 4s. to 5s. a-head more than the individuals of the other lot; and this increased value of the sheep will cover all the expense of oil-cake, turnip machines, and the extra wages of attendance in working them; and a feeder will receive a handsome return, remunerating him for what may be held by those unacquainted with this mode of feeding an extraordinary outlay.

TURNIP-TREE. See PACHYRHIZUS.

TURNPIKE. See ROAD.

TURN-REST. See PLOUGH.

TURNSICK. See HYDATID.

TURNSOLE. See LITMUS.

TURNSTONE,—scientifically *Strepsilas*. A genus of birds, belonging to the longirostrous family of waders. They are allied to the sandpipers, but stand rather low. Their bill is short, conical, pointed, and without any depression or inflation; their nasal fossæ do not extend along more than half the bill; their toes are without membranes; and their thumb barely reaches the ground. They take the name of turnstone from the habit of overturning stones with their bills in search of worms and molluscs.—The common turnstone, *Strepsilas interpres*, occurs in many parts of both of the great continents of the world; and frequents the coast of Britain, either singly or in small flocks, from August till May. It resembles the sanderling or some of the small plovers; and has a variedly red and black mouth, white head and belly, and black cheeks and breast; but its young, who arrive with it in August, have none of the bright strong tints of the adult. This bird has a total length of 9½ inches; and it feeds on worms, thin-shelled molluscs, and the smaller crustacea.

TURNWREST PLOUGH. See PLOUGH.

TURPENTINE. The resinous semi-fluid product of pine trees and fir trees, and of the *Pistacia terebinthus*. Turpentines have a peculiar and somewhat aromatic odour, and a pungent, heating, bitterish taste; they are very inflammable, and burn with a white flame, and give off much smoke; and they readily combine with fixed oils, and dissolve in ether or alcohol, but do not mix with water. They have a place in the materia medica of both human and cattle pharmacy; and act externally as irritants and rubefacients, and internally as stimulants, diuretics, cathartics, and anthelmintics; but they require to be used with discrimination, and have very various adaptations to different species of animals, to different parts of the body, and in different states of the system.

Common turpentine exudes in transparent drops, from artificial wounds near the foot of the wild or Scotch pine; and may be obtained to the amount of from 6 to 12 pounds a-year for about a century from one tree. It varies in consistency and comparative purity and other characters, according to the precise method in which it exudes; and it is purified by exposure to the sun's rays in barrels with perforated bottoms, and by liquefying there, and filtering through the bottoms. It generally has a greater opacity than other turpentines, a greater consistency than honey, and a dirty yellow colour; it is of main use for yielding the essential oil of turpentine; and it serves well as an ingredient in some ointments in farriery, but is not nearly so much used in any department of medicine as Venice turpentine.

Venice turpentine is obtained from the larch, and from one or more of the American firs. It exudes from a tapping in trees of above twelve years of age; and is produced by a vigorous tree to the amount of 7 or 8 pounds a-year for 40 or 50 years. It is less unpleasant to the smell and taste than common turpentine, and has a more fluid consistency, and a yellowish colour. It is used in veterinary medicine, internally as an ingredient in cough mixtures and diuretic balls, and externally as a chief ingredient in stimulating and digestive ointments and in mange mixtures. The Canadian turpentine or Canada balsam is noticed in the article CANADA BALSAM; and the Chian or Cyprus turpentine is noticed in the article PISTACHIA-TREE.

The spirit, oil, or essential oil of turpentine is obtained by distillation with water from either common or Venice turpentine; and floats on the top of the water in the receiver of the still; and is easily separated thence, and afterwards rectified. About 120 lbs. of it are obtained from 500 lbs. of good turpentine. It is quite liquid, perfectly limpid and colourless, and extremely light, volatile, and inflammable; it has a peculiar and very powerful and penetrating odour, and a bitterish, very pungent taste; it is very sparingly soluble in cold alcohol, but accords in most of its other chemical qualities with the essential oils; it is believed by the majority of chemists to consist of 14 equivalents of carbon, 1 of oxygen, and 10 of hydrogen; and it is converted, by a stream of chlorine passing through it, into a substance similar to camphor. It is used in various ways and for widely different purposes, internally and externally, both in human medicine and in veterinary medicine; but requires to be prescribed with much more discrimination and a much higher professional knowledge than even the semi-fluid turpentines. A chief internal use of it, for example, is as an anthelmintic in man and an antipasmodic in the horse,—but it is defeated or rendered mischievous by alcoholic accompaniment in man, and possesses very doubtful vermifugal power upon the horse; and a chief external use of it in both is as an irritating or blistering substance,—yet it may be terribly disastrous if applied to man's head, and is sometimes very injuriously exciting when applied to any one of many parts of the horse.

TURPENTINE MOTH. Two insects of the tortrix family of moths. They take their name from the circumstance of causing turpentine tumours in young fir-trees; and they sometimes inflict considerable damage on young fir plantations. The one is scientifically called *Cnephasia resinella* and the other *Argyrolepia turionella*. The former measures about 8 lines from tip to tip of the wings; its upper side is dark brown; its back is marked with longitudinal silvery lines; its wings are traversed with lines of lighter hue than the ground colour, and of a metallic lustre; its under wings are almost black, with a yellow and brownish line just within the fringes; and its under side is wholly of a light

greyish-brown colour. The female appears in May or June, and lays her eggs on the young shoots of fir trees; the larvæ penetrate to the alburnum, and cause the terebinthine sap to form excrescences, which gradually harden; and the shoots either wither entirely away, or remain vital in only the lower part, and do not throw out young branches thence till the following year. The *Argyrolepia turionella* is so similar in appearance to the *Cnephasia resinella* as to be readily mistaken for it by an unpractised observer; and it has similar habits, and works mischief in a similar way, by depositing its eggs on the buds of young fir-trees. The only known remedy is to destroy the turpentine tumours, or to cut off and burn the infected twigs, at the time when they are inhabited by the active larvæ.

TURPENTINE (Oil of). See Turpentine.

TURPENTINE TREE. See Pistachia-Tree.

TURRÆA. A genus of ornamental, tropical, ligneous plants, of the bead-tree family. Several species, small evergreen trees of naturally about 20 feet in height, have been introduced to the hothouse collections of Britain; and they love a soil of peaty loam, and are propagable from cuttings.

TURRITIS. See Tower Mustard.

TUSHES. See Tooth and Age of Animals.

TUSSAC-GRASS,—botanically *Dactylis Cæspitosa*. A hardy, forage grass, of the cock's-foot genus and fescue tribe, introduced to Britain in 1844. It almost excited a sensation throughout the well-informed part of the British agricultural community at its introduction; and has since been subjected to a great variety of cultural experiments, in widely different ways and distant situations, in the hope of its proving an exceedingly valuable addition to our field-plants,—particularly on poor soils and swampy grounds, along the shores and upon sea-islands. It abounds in the Falkland Islands, and has been found also in Staten Land, in the Auckland Islands, in the Straits of Magelhaens, and in the vicinity of Cape Horn. It has long been known to botanists; and is alluded to by most of the great navigators who have touched at the Falkland Islands since the days of Cook; but was not brought prominently into notice till the recent voyage of discovery in the antarctic regions under the superintendence of Captain Ross. It is called tussac-grass from its roots being so densely matted together as to make the lower parts of its stalks form a large tuft or tussac. These basal or columnar portions, formed by the close approximation of the stems or culms, often rise to a considerable height—from 4 to 6 feet; and the long tapering leaves then diverge from them, and hang down all around, often in a very graceful curve, like the falling waters of a *jet d'eau*. The masses are insulated, generally a few feet apart; and the leaves, meeting above, form a kind of arched roof, beneath which the ground is generally quite bare of vegetation. A tussac ground thus forms a complete labyrinth; and a man may walk among its green arcades completely concealed from view. The earlier naturalists who examined it thought it to be a fescue, and called it *Festuca flabellata* and *Festuca cæspitosa;* but Forster notices it under the name of *Dactylis cæspitosa*,—and that appellation is now retained, as a careful examination of its character leaves no doubt that it belongs to the genus *Dactylis*. The tussac is perennial. The root consists of a dense mass of tortuous fibres. The stems, which spring from the little hillock formed by the roots, are numerous, erect, branched or divided only at the base, from 3 to 4 feet long, smooth, and compressed. The leaves are numerous, the lower ones very long, not unfrequently from 5 to 8 feet, about an inch broad at the base, and gradually tapering to a point; from above the middle they are curved downwards, or even pendent; the stem-leaves become gradually shorter upwards, and are of a pale glaucous or sea-green colour; and the other leaves are pale yellow. The panicle is a span long or upwards, very dense, forming a somewhat interrupted spike, nearly two inches broad, compressed and obtuse; the branches short and erect; the rachis angled. The spikelet is composed of three or four florets, of a pale yellow-green colour; the calycine glumes are lanceolate, acuminate, longer than the spike of flowers, slightly keeled, shortly ciliated on the back, $3\frac{1}{2}$ lines long, the margins a little involute, and, as well as the apex, membraneous and transparent, the superior one a little longer than the other, three-nerved, the nerves ciliated; the lower glume or palea of the corolla is ovate, concave, compressed, and sharply keeled, bluntly trifid at the apex, and five-nerved; the stamens amount to three; the anthers have a pale yellow-colour; the ovary is nearly ovate and glabrous; and the fruit is elongate-ovate, or almost cylindrical, slightly trigonous, of a pale yellow colour, and smooth.

It will at once appear, from the length and breadth of the leaves, the dimensions of the culms, and the profusion in which both these are produced, what an immense quantity of herbage this plant is calculated to afford. Both the leaves and the stems abound in saccharine matter, and form a most nutritious food. The inner portion of the stem, for a little way above the root, is soft, crisp, well-flavoured, somewhat akin in gout to the kernel of a nut, and is often eaten by the inhabitants of the Falkland islands. The young shoots also are boiled and eaten like asparagus. But it is as affording pasturage for cattle that the tussac is to be chiefly valued. The Falkland Islands have long been known to be inhabited by many wild cattle and troops of horses; and these are principally supported by this grass, and prefer it to every other kind of food; and in common with every herbivorous animal on the islands, they devour it with avidity, and are affirmed to fatten on it in a short time. Their predilection is shown for it both in a green state

and when dried, insomuch that cows and horses often eat the thatch from the roofs of the houses when this happens, as it often does, to be composed of tussac grass. "During several long rides into the country," says Lieut. R. C. Moody, the Governor of the Falkland Islands, "I have always found the tussac flourishing most vigorously in spots exposed to the sea, and on soil unfit for any other plant, viz., the rankest peat-bog, black or red. It is singular to observe the beaten footpaths of the wild cattle and horses, marked like a foot-track across fields in England; extending for miles over barren moor-land, and always terminating in some point or peninsula covered with this favourite fodder; amid which one is almost certain to meet with solitary old bulls, or, perhaps, a herd of cattle—very likely a troop of wild horses, just trotting off as they scent the coming stranger from afar. I have not tried how it would be relished if made into hay, but cattle will eat the dry thatch off the roof of a house in winter; their preference to tussac-grass being so great that they scent it a considerable distance, and use every effort to get at it. Some bundles, which had been stacked in the yard at the back of Government House, were quickly detected, and the cattle from the village made, every night, repeated attempts to reach them, which occasioned great trouble to the sentry upon duty." "Tussac," continues the same authority, "is green all the year round; frost does not appear to injure it, nor does snow cover it; it is a soft, succulent, and highly nutritious grass, extremely relished by all animals—cattle, horses, sheep, and pigs. There is an island in Berkeley Sound that can be reached at low water from the main; the area of this island is as nearly as possible 800 acres, and there are about 400 acres of tussac-grass upon it; the remainder of the island is thinly covered with coarse wing-grass and rush on peat-bog—a very wretched piece of pasture-land, affording scarcely any nutriment. Last autumn I caused the Government herd, consisting of 800 head of cattle and about 60 or 70 horses, to be placed on this island for the winter months; the animals remained on the island nearly six months, with no other nutriment than what the island afforded; towards the end of that time, they began to get poor, and the tussac was eaten down to the roots; by next autumn it will have entirely recovered. I am compelled to let the cattle graze the tussac from want of hands and means to make different arrangements; nor do I consider any other plan a matter of sufficient moment in the present state of the colony to warrant the outlay requisite to economise properly this invaluable food. But in England, where labour is cheap, I would act differently; the cattle could be folded in an adjoining paddock to the field of tussac, and fed over the wall or fence by men cutting the tussac in bundles, commencing with the upper row and passing regularly through the field; by the time they had cut the last row, the first would be ready to cut again. Had such a plan been adopted by me in the island I mentioned above, I feel confident the 400 acres of tussac would have amply supplied the 800 head of cattle for twelve instead of six months. It is incredible how much is injured by being trodden down and eaten too close; and the horses, from preferring the root, do more mischief than the cattle. I ought to mention that the plant is of slow growth, and would probably be three years in coming to perfection, during which period, however, it might be cut annually with advantage. When once full-grown, it springs up rapidly after being cut down, the blades reaching their full height of 7 feet by the end of summer, though cut down in the spring. I kept up a favourite horse in a loose box one winter, and had him fed entirely on tussac, cut for him and given green. He ate it greedily, and was always in excellent condition; but as a general rule, I should consider it soft food for a horse doing any work. When it is remembered that this invaluable provision of nature thrives luxuriantly where scarcely any other vegetation will exist—that it is most nutritious, and much relished by cattle, it is impossible to resist feeling the most earnest desire to see it extensively tried in those portions of the United Kingdom which in climate and soil bear some resemblance to the Falkland Islands. I might easily expatiate on the extreme beauty of its vegetation, covering rocky storm-beaten promontories and small islands with a dark rich verdure, always reminding me of tropical luxuriance; but its importance in a practical point of view is what I am desirous of making fully known to all interested in agricultural pursuits."

Tussac, in its natural state, is generally found growing near the shore, and flourishes best where the saline spray dashes over it. Indeed, exposure to the sea-breeze, and the peculiar influences which emanate from the ocean, are conditions which seem essential to its prosperity. It is then only that it reaches its most stately proportions, and assumes that exuberant and imposing form, which have led one author to speak of it as the "splendid tussac-grass, the gold and glory of the Falklands." As it recedes from the ocean, it becomes dwarfed and sickly, as if out of its kindred and appropriate element, in this respect resembling our own native *Arundo arenaria*, *Triticum junceum*, and certain other gramineous plants. As with these also, and a considerable number of other species, the glaucous colour of the tussac grass may be regarded as indicating it to be a littoral plant; for it would seem as if many of the plants growing near the sea caught their hues, as they are known to acquire certain other of their properties, from the element in their vicinity. It is probable that the saline matter the plant derives from the spray and sea breezes, contributes not a little to

render it so palatable to cattle. The ground on which the tussac grass flourishes best is a wet peaty soil, often very bleak and poor, and scarcely capable of sustaining any other kind of herbage. "If the shore be bold, and the sea-bank high and rocky," says Lieut. R. C. Moody, in reference to the experimental culture of it in Britain, "I should choose the most exposed points. If the spray, but not the actual wave, dashes over it, so much the better. I do not think that sowing it in the shifting sand would answer in the first instance, though when the grass once takes root in any soil, the drift-sand blowing over it, amongst it, and almost burying it, does not seem to injure it. I would try some in the sand that has been fixed by the bent, but as near the sea as possible. The tussac loves the spray, and the finest plants are almost growing in the water. If the breezes from the sea carry a great quantity of moisture to the peat-bog behind the tract of sand, I conceive the tussac-grass would answer extremely well in it. We have tussac-grass growing on peat-bogs on exposed islands in the Falklands, in places 800 and 1000 feet above the sea; but these sites are exposed to the westerly gales, which are laden with moisture. Some of the finest young plants I have seen grew from seed sown in rich mould in my garden, 300 yards from the shore of a deep inland harbour, and protected from the winds by a high turf wall. This artificial mode seems to contradict what I before stated. Nature prefers the first-mentioned places; but as the latter is a fact, I would recommend both to be tried. In the garden, I was so successful with the plants from seed, that I proceeded to transplant suckers from the wild ones on the rocky shore to the rich mould in the garden, and I found them to thrive vigorously. I took suckers from these again, also from the plants raised by seed, and planted out more rows. Every plant answered admirably. I cut them down, and they grew more bushy and spread, throwing out fresh suckers; and I could soon have filled a paddock with the plants. In laying out a piece of ground for tussac-grass, the following circumstances must be borne in mind:—the plant grows in bunches occupying from 2 to 3 and sometimes even 5 feet in diameter, and the blades of grass when full-grown are 7 or 8 feet long. The roots seem forced up from the ground, and I have been in patches of fine full-grown tussac in which a man on horseback is almost concealed. I should therefore sow the seed in rows 2 feet apart, some in a garden, and some on exposed points of peaty soil close to the sea, and within reach of the spray, carefully weeding between the plants as they grow up. When they are 9 inches or a foot high, the suckers might be separated and planted out 3 feet apart in rows. As the plants grow large, every alternate row should again be planted out, in order to leave room for a man, cow, or horse to pass between the rows without treading down the plants. To raise from seed appears a more uncertain and much slower method than that of planting out suckers from the finest plants." A coloured figure of tussac is given in *Plate XXI.*

TUSSILAGO. See Colt's Foot.

TUTSAN. See Hypericum.

TWAYBLADE,—botanically *Listera.* A small genus of curious, indigenous, perennial-rooted, annual-stemmed herbaceous plants, of the orchis order. The ovate-leaved species, *L. ovata*, called by some botanists *Neottia latifolia*, inhabits woods, groves, and other shady places; and has a height of about a foot; and carries green-coloured flowers in May and June. The heart-leaved species, *L. cordata*, inhabits moist heaths; and has a height of about 3 or 4 inches; and carries brown-coloured flowers in June and July. Both species may be cultivated in the garden in a mixed soil of loam and peat, and are propagated by division of the root.

TWEEDIA. A genus of ornamental, exotic, twining plants, of the figwort family. The blue-flowered species, *T. cærulea*, was introduced to the greenhouses of Britain about 13 years ago from Buenos Ayres. Its root is fibrous; its stem is slender, twining, scarcely branching, somewhat woody, and about 6 feet high; its whole surface, except the upper lamina of the corolla, is clothed with whitish downy hairs; its leaves are opposite, petiolate, cordate-lanceolate, entire, from 1½ to 2 inches long and ½ an inch broad; its inflorescence is umbellate, with from 3 to 5 flowers in each umbel; and its corolla is rotate and five-parted, and has a pinkish colour on the under surface, and a fine sky-blue colour on the upper surface. When the plant is trained to a neat trellis in a sunny exposure, the effect of its beautiful flowers is extremely fine. The plant loves a soil of sandy loam, and may be propagated from cuttings. A dye similar to indigo might probably be obtained from its flowers.

TWITCH. An instrument used for holding a horse in restraint and making him stand quiet during a surgical operation. It is made by fixing a noose of cord to the end of a stick; and is put on the horse's upper lip and twisted rather tight.

TWITCH-GRASS. See Couch-Grass.

TYLOPHORA. A genus of ornamental, exotic, evergreen twining plants, of the swallow-wort family. Three species, all about 10 or 12 feet high, blooming in June and July, loving a soil of peaty loam, and propagable from cuttings, have been introduced to British gardens from India and Australia; and two or three more are known. The name tylophora signifies "wart-bearing," and alludes to the leaves of the corolla.

TYPHA. See Cat's-Tail.

TYPHUS FEVER. See Fever.

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UDAL TENURE. An old and peculiar local tenure in Orkney and Shetland. A proprietor of land holding by this tenure pays certain duties to the lessee of the crown-rents and granter of the bishop's rents, and pays also his proportion of any general tax which is levied on the kingdom, but requires no other title to his property than mere possession, certified in the rental book of the lessee of the crown-rents. But holders by udal tenure long ago began to find their seeming privilege a serious evil, and were glad to exchange it for a system of regular charters and sasines.

UDDER. The glandular organ of a cow, a mare, an ewe, or other female mammal which secretes milk. The udder of the cow is an unique mass, composed of two symmetrical parts, simply united to each other by a cellular tissue, lax, and very abundant; and each of the parts comprises two divisions or quarters, which consist of many small granules, and are connected together by a compact laminous tissue; and from each quarter proceed systems of ducts, which form successive unions and confluences, somewhat in the manner of the many affluents of a large river, till they terminate in one grand excretory canal, which passes down through the elongated mammilary body called the teat. Its lactiferous tubes, however, do not, as might be supposed, proceed exactly from smaller to larger ducts by a gradual and regular enlargement, because it would not have been proper that the secretion of milk should escape as it was formed, and therefore we find an apparatus adapted for the purpose of retaining it for a proper time. This apparatus is to be found both in the teat and in the internal construction of the udder. The teat resembles a funnel in shape, and somewhat in office; and it is possessed of a considerable degree of elasticity. It seems formed principally of the cutis with some muscular fibres; and it is covered on the outside by cuticle, like every other part of the body; but the cuticle here not only covers the exterior, but also turns upwards and lines the inside of the extremity of the teat, as far as it is contracted, and there terminates by a frilled edge, the rest of the interior of the teats and ducts being lined by mucous membrane. But as the udder in most animals is attached in a pendulous manner to the body, and as the weight of the column of fluid would press with a force which would, in every case, overcome the resistance of the contractions of the extremity, or prove oppressive to the teat, there is, in the internal arrangement of the udder, a provision made to obviate this difficulty. The various ducts, as they are united, do not become gradually enlarged, so as to admit the ready flow of milk in a continued stream to the teat, but are so arranged as to take off, in a great measure, the extreme pressure to which the teat is exposed. Each main duct, as it enters into another, has a contraction produced, by which a kind of valvular apparatus is formed in such a manner as to become pouches or sacs, capable of containing the great body of the milk. In consequence of this arrangement, it is necessary that a kind of movement upwards, or lift, should be given to the udder, before the teat is drawn, to force out the milk, and by this lift the milk is displaced from these pouches, and escapes into the teat, and is then easily squeezed out; while the contractions or pouches, at the same time, resist in a certain degree the return or reflux of the displaced milk. This valvular arrangement is thus a very beautiful combination of exquisite mechanism with organic functions; and readily explains why a series of lifting actions is requisite in the artificial milking of the cow, why the calf, the lamb, and the colt jerk up their nose into the udder, and why the pig and the puppy push up the teat with their feet. The comparative smallness of the mare's udder, and its having only two teats instead of the four of a ruminant, seem to be a benign provision for facilitating her speed of motion and severity of labour, and are amply and beautifully compensated by the special adaptation of the qualities of the milk to the wants of the foal.

Inflammation in the cow's udder is a somewhat common disease, and frequently assumes a very severe character. One cause of it is the simple but roguish practice of allowing the milk to accumulate excessively in the udder, when about to send cows to market, with a view of making them appear greater milkers than they really are. The consequence of this 'hefting,' as it is termed, is a painful distention of the vessels; and this is frequently followed by inflammation, which attacks either the glandular structure or the cellular substance by which it is united. In the first case, the disease generally attacks the whole of one quarter, or it may extend to the half or whole of the udder, and is always sudden in its attacks, rapid in its progress, and dangerous and obstinate in its effects. The quarter or whole of the udder becomes suddenly hot, painful, and hard to the touch; there is a degree of symptomatic fever present; the secretion of milk is par-

tially or completely suspended; and if any is formed, as sometimes occurs in mild cases, the milk is either mixed with curd, is like whey, is bloody, or, instead of either, there is pus; these different states of the secretion varying according to the intensity of the inflammation, or the length of time it has existed.—Another cause is the coarse mode of milking,—the method of tearing and tugging at the teat,—which is practised by some dairy-maids. In this mode of milking, the operator does not imitate the principles which instinct has taught the calf, and which depend on the valvular structure of the lactiferous outlets of the ducts; but she merely dips her hand into a little milk, and, by successively stripping the teat between her fingers and thumb, unloads the udder; and she in consequence more or less irritates the teat, and renders it liable to cracks and chops, which are followed by inflammation, extending to the rest of the quarter. This accounts for the disease occurring more frequently among the cows under the charge of one milker than it does in those under the charge of another; and as this practice is more common in some parts of the country than in others, it also accounts for the disease being more common in these parts.—Another set of causes is the excited state of the constitution about the period of parturition, the arousal of the sympathy which exists between the udder and the uterus, the shock and struggle of the glandular powers of the udder at the commencement of the process of secreting milk, the retention of the placenta beyond a due period after parturition, and the derangement of the organs of digestion, specially about the time of parturition, but generally also at any other period.—Other causes are travelling with a loaded udder soon after parturition, lying on a rough hard surface, the virus of cow-pox, and various external injuries, such as wounds, blows, and bruises.

"In all cases of inflammation of the cow's udder, with perhaps the exception of cases of it from external injuries," says Professor Dick, "the great object we must have in view, is to obtain resolution of the inflammation, which is the most favourable termination of it in almost every part; but we frequently find that the violence is so great, that instead of subsiding, mortification rapidly ensues, while in other cases, abscesses form in various parts of the udder. It will be found advisable, when the udder becomes inflamed, to abstract a quantity of blood from the animal, say from four to six quarts. This may be either taken from the neck or from the mammillary or 'milk veins,' as they are termed, and which run so conspicuously along the surface of the abdomen, as they proceed from the udder. A pound or a pound and a-half of Epsom salts should also be given, and the dose repeated if a full effect is not produced in from 12 to 18 hours, and fomentations of hot water as constantly applied as possible; and a sort of suspensory bandage would be found of service to relieve the pressure and weight, and may be used during the fomentations. An emollient poultice may be applied at night, composed of bran and linseed meal; or if the pain is great, decoctions of chamomile flowers may be used with the fomentations, and a hemlock poultice at night; and, should these means not seem to afford relief, some cooling lotion may be tried, as nitre and common salt, each 10 oz. dissolved in a quart of water, or 1 oz. Goulard's extract of lead, half a pint of vinegar, and a quart of water; or, when the more active inflammation has subsided, some discutient lotion may be used, such as ½ oz. muriate of ammonia, dissolved in water, vinegar, or spirits of wine, each 8 oz. and applied twice a-day. In these severe cases, the bleeding and physic should be freely repeated, and the poultices and fomentations continued until the inflammation is subdued, and the wounds have assumed a healthy appearance, and well healed up. It often happens that the disease is materially increased by the irritation arising from milking while the teat is chopped, or has cow-pox on it, and is in a state of inflammation; but although this is the case, the contents of the ducts must be removed, if there is any secretion, because when the secretion accumulates, it distends the parts, and thereby increases the disease. It is, however, often difficult to extract the fluid from the teat, more especially in those cases where it is sore, and from which probably the whole mischief has arisen, because the swelling interrupts the passage; or if the inflammation has not completely suspended the secretion, it produces a morbid one; and instead of a uniform fluid, there is a mixture of coagulated milk, or coagulum from the blood, which, from its thick curdled consistence, cannot pass through the opening of the teat; and which therefore serves to plug up the passage, and neither can pass itself, nor allow the thinner part of the secretion to pass. To remedy this, I have been informed that it is sometimes the practice to cut off the extremity of the teat; but this, while it may in some measure serve to relieve the inflammation of the quarter of the udder, evidently precludes the chance of a useful recovery of the part. It is therefore better to make a perpendicular incision in the teat, by which the matter may be discharged, and there will then be a chance of the teat healing up and fulfilling its function, should the secretion be restored. But as the inflammation is not in all cases alike active, it will be found that sometimes the curdled matter may be removed through the opening of the teat, with sufficient readiness to answer all the purposes required, and this may be done either by introducing a small silver probe or a canula."

ULCER. An abraded and morbidly secreting surface on any part of the body of an animal. It breaks down or wears away parts which become absorbed through the medium of the lymphatics,

and it always produces a discharge of pus or of some other morbid secretion. It may arise from one or more of many widely different causes; and may assume any one of many widely different aggregate characters; and must be treated, in each instance, according to its cause and character. It may be a simple ulcer, arising from a severe or neglected or mismanaged wound or bruise; or a sinuous ulcer, running under the integuments, and having a narrow but not callous orifice; or a fistulous ulcer running deeply, tubularly, and ramifiedly under the integuments, and having a narrow and callous orifice; or a fungous ulcer, covered with fungous flesh, and continuously reproducing it; or a putrid ulcer, more or less of the nature of gangrene or of an eating fetid sore; or a carious ulcer, depending on caries in a bone or a cartilage; or a glanderous ulcer, more or less identical with the disease of glanders in the horse; or a cancerous ulcer, more or less identical with canker in the horse's feet, or with phagadenic cancer in any part of the body of either the horse or any other animal. See the articles WOUND, ABSCESS, FISTULA, FUNGUS, CARIES, GANGRENE, GLANDERS, FARCY, and CANCER.

The simple recent ulcer of horses or cattle generally heals spontaneously, or with such easy aid as the application of tincture of myrrh, solution of alum, or some other mild astringent; but a foul chronic ulcer, whether it have or have not a fistulous character, is sometimes so stubborn as to require both skilful and very persevering treatment. "When ulcers have continued for a long time," says Delabere Blaine, with special reference to the horse, "it is often necessary to employ constitutional remedies to establish a cure. In full habits we increase the other secretions, as those of the bowels, the kidneys, the skin, &c., by purgatives, diuretics, and such remedies as act on the skin. We also lessen the excess of morbid secretion of pus, by establishing a new and artificial drain in the neighbourhood, which is done by setons or by rowels. In some cases, instead of existing plethora, the ulcer has occasioned or is accompanied by great irritability of system, which must be combated by opium, and other sedatives; or if debility become very apparent, tonics must be given, together with a liberal diet. In general cases, stable soiling, a coarse of carrots, or other total change of food, assists the healing and restorative process greatly. In general cases, the longer an ulcer has lasted, the more obstinately will the vessels have gained a diseased habit, and the more difficulty there will be to bring them back to a healthy state. The external means employed for this purpose are usually three,—stimulating injections, seton, or incision."

ULEX. See FURZE.

ULMIN. See HUMUS.

ULMUS. See ELM.

UMBEL. An inflorescence which has a number of flower-stalks diverging from a common centre like the rays of an umbrella, and bearing their flowers on their extremity, all at nearly one elevation. When each ray is undivided, so as to bear but one flower, the umbel is said to be simple; and when each ray is ramified, so as to divide into a number of pedicels, and to terminate in a number of flowers, the umbel is said to be compound. Familiar instances of umbellate inflorescence are the carrot, the parsnip, and the common hemlock.

UMBELLIFEROUS PLANTS, or UMBELLIFERÆ. A natural order of calyciflorous exogens, "one of the least attractive groups of plants," says Loudon, "and at the same time one of the most important to the world. They are not more useful as food, than they are dangerous as poison. While in their native ditches, they are often suspicious lurid weeds; but under the influence of cultivation, they lay aside their venom, and become wholesome food for man. They are generally recognised by their hollow stems and cut leaves, with what botanists call a sheathing petiole, that is to say, with a petiole the base of which wraps round the stem. Their flowers are mostly white or yellow; rarely, as in *Astrantia*, some species of *Caucalis*, and others, of a pink colour; or blue, as *Eryngium*. The inflorescence is umbellate; and their fruit consists of two ribbed portions, improperly called seeds, which are held together by a common axis, and a thickened discus. All are natives of damp ditches or way-sides, in cool parts of the world; in the tropics they are extremely rare. The simplicity of their structure, and uniformity of their appearance, have rendered their classification a matter of very great difficulty. It has been attempted in modern days by Sprengel, Lagasca, Koch, and Decandolle, all of whom have added much to our knowledge. The culinary and agricultural importance of many species is well known. The parsnip and carrot form a large part of the staple winter store of the inhabitants of Europe, as the *Arracachas* do of those of South America; and the Prangos of Thibet is supposed to be the most important and productive of any in the whole world, as a forage plant. The medicinal properties of Umbelliferæ are not more powerful than they are at variance with each other. While the seeds of some are aromatic and stimulating in the highest degree, the fresh roots and leaves of others are not less narcotic. This has been supposed to arise from the difference in the state of the sap in different parts of the plant; and it has been thought that the narcotic principle is only to be found in the ascending sap, while the aromatic stimulant properties are found in the juices which are fully elaborated and matured." A general rule of some value to persons but indifferently acquainted with botany—the more so as many of the most common wild Umbelliferæ of entirely opposite properties are so nearly alike in general appearance as to be readily mis-

taken for one another by the ignorant—is that those species which inhabit watery sites are usually poisonous, and those which inhabit high dry sites are usually wholesome; and so much does this rule hold that it may possibly suggest some explanation why certain species which are poisonous in their wild state become wholesome by cultivation, and why certain other species, such as *Œnanthe fistulosa* and *Œnanthe crocata*, are violently poisonous in some districts and comparatively or wholly innocuous in others. Two of the most remarkable instances of species which are poisonous in their wild state becoming wholesome and esculent by cultivation occur in the common celery and in *Œnanthe pimpinelloides*. Some of the most remarkable medicinal species are those which yield galbanum, opopanax, and asafœtida. Koch and Decandolle classify the Umbelliferæ into three suborders, according to the form of the seed. The smallest suborder, called Coilospermæ, has channelled seeds, and comprises only one tribe, represented by the genus coriandrum; the middle suborder, called Campylospermæ, has curved seeds, and comprises three tribes, represented by the genera caucalis, scandix, and smyrnium; and the largest suborder, called Orthospermæ, has straight seeds, and comprises eleven tribes, represented by the genera hydrocotyle, sanicula, ammi, seseli, angelica, peucedanum, tordylium, siler, cuminum, thapsia, and daucus. About a dozen hothouse species, upwards of 50 greenhouse species, and between 500 and 600 hardy species—nearly all herbs and belonging to upwards of 100 genera—at present occur in the gardens and wilds of Britain.

UMBILICUS. See Navelwort.

UMBRELLA-TREE. Two ornamental exotic trees of about 30 or 35 feet in height,—the one the *Magnolia tripetala*, a hardy, deciduous, white-flowered native of North America,—and the other the *Hibiscus guineensis*, a tropical, evergreen, purple-flowered native of Western Africa. Both occur in British collections.

UMBRELLA-WORT,—botanically *Oxybaphus*. A genus of curious exotic plants, of the order Nyctagineæ. About a dozen species, varying in height from 1 foot to 6 or 8 feet,—some evergreen erect herbs, others evergreen trailers, and others deciduous trailers,—some hardy and others requiring a little protection,—most purple-flowered and blooming in July and August,—have been introduced to British collections from various parts of North America; and the greater number love a soil of sandy peat, and require to be propagated from seed.

UNDER-DRAINING. See Draining.

UNDERWOOD. Shrubby, stunted, or coppice growths of forest trees,—either the literal 'underwood' of natural forests, or any kind of wood which is too small to be accounted timber. See the articles Coppice, Plantation, and Timber.

UNIOLA,—popularly *Seaside-Oat*. A genus of exotic grasses, of the fescue tribe. Four hardy perennial species, two of them about 4 feet in height, the other two less than 1 foot in height, and all blooming toward the end of summer, have been introduced to British collections from North America; but they do not possess any agricultural interest.

UNONA. A genus of ornamental, tropical, evergreen, ligneous plants, of the custard apple family. Nearly a dozen species, variously shrubs, climbers, and small trees, mostly brown-flowered, and all loving a soil of peaty loam, and propagable from cuttings, have been introduced to British hothouses from India and Guiana; and about 30 more are known. The esculent species, *U. esculenta*, a climber of 10 or 12 feet in height, introduced about 30 years ago from Madras, ranks in its native country as a fruit tree.

UNSOUNDNESS. See Soundness.

URANIA. A magnificent, evergreen, tropical plant, of the banana tribe. It naturally inhabits the sultriest forests of Madagascar; and was, a considerable time ago, introduced to British collections. It takes its name of urania, or "the heavenly plant," from the stately grandeur of its appearance; and it constitutes a genus of itself, and is specifically called *speciosa* or the showy. It attains a height of about 20 feet, and carries red flowers, and loves a soil of peaty loam, and is propagated from suckers.

URANIUM. One of the rare metals. It was discovered in 1789 by Klaproth, in the mineral called pitchblende, which is a compound of protoxide of uranium and oxide of iron. Uranium does not naturally occur uncombined; and though known to be a simple or elementary body, is not well understood in its detached state. The protoxide of it consists of one equivalent of the metal and one equivalent of oxygen, and has a very dark green colour, and most powerfully resists the action of heat, and forms green salts by combination with acids; and is employed in the arts for giving a black colour to porcelain. The peroxide of uranium consists of two equivalents of the metal and three equivalents of oxygen, and has a yellow or orange colour, and forms salts of a similar tint, and combines with alkalies as well as with acids, and suffers permutation into the protoxide by the action of strong heat, and is employed in the arts for giving an orange colour to porcelain. Sulphuret of uranium is formed by passing the vapour of bisulphuret of carbon over strongly heated protoxide of uranium, and has a dark grey colour, almost black, and suffers reconversion into the protoxide when heated in the open air.

URARIA. A genus of ornamental exotic plants, of the hedysarum division of the leguminous order. Six or seven species, varying in height from 1½ to 8 feet, carrying either purple or lilac or pink flowers in the latter part of summer, all but one evergreen shrubs, some of them having pinnate leaves, two or three paired, and a terminating odd leaflet, others having trifoliate leaves,

with the terminal ones petiolate, have been introduced to British gardens from India, China, Brazil, and Western Africa; and all love a soil of sandy loam and require to be propagated from seeds. Several were ranked by Linnæus and his immediate successors among the true hedysarums.

URATES. Salts of uric or lithic acid. This acid is a common constituent of urinary calculi; and always occurs in healthy urine, combined with some alkali; and is precipitated from urine by means of any acid which robs it of the alkali. It forms at first in brick-coloured crystals; but when pure, it is white, tasteless, and inodorous. It consists of 6 equivalents of carbon, 2 of hydrogen, 3 of oxygen, and 2 of nitrogen. It is insoluble in alcohol, and cannot be thoroughly dissolved in less than about 10,000 times its own weight of water at 60° Fahr. It reddens litmus paper, and combines with alkalies and alkaline earths and oxides, but does not effervesce with alkaline carbonates. It is decomposed by chlorine; and when acted on by nitric acid, it leaves a beautiful purple residuum, with distinct acid properties.

The principal urates, or pure salts of uric acid, are those of ammonia, potash, and soda. Urate of ammonia is soluble to a considerable degree in boiling water, but more sparingly in cold water. The urates of soda and potash, when neutral, are of very sparing solubility; but an excess of either of the fixed alkalies takes up a large quantity of the acid. See the articles Urea and Urine.

The urate of the manure market is an artificial fertilizer prepared by a Company in London; and ranks in some respects with special manures, and in others with factorial and patent ones. See the article Manure. It is a dry powdery substance; and is applied by the drill in the quantity of about 6½ cwts. per acre, and has the reputation of being a very powerful fertilizer, and acts with equal or at least similar effect on turnips, tares, rye, wheat, and winter barley. Two competent and credible experimentalists reported as follows respecting it in September, 1841: —"I applied it broadcast," said the one, "on two acres in the centre of a twelve-acre field of sandy land, at the rate of 6½ cwts., and at the cost of 33s. per acre. The rest of the field I dressed with bone-dust at the rate of two quarters, and costing 52s. per acre. Up to the present time, I perceive no difference whatever between the two, the whole field promising to be a very good crop. The turnips are drilled at 18 inches apart, and set out at the same distance." "I drilled a ton of urate upon 3 acres, in rows 17 inches apart," said the other, "upon a very hot gravelly soil. The adjoining portion of the field was manured, in the usual way, with 14 loads per acre of farm-yard manure. The turnips in the urate were fit to hoe 7 days before the other manured part; and from their first appearance, a stranger could point where the urate commenced and ended. The difference is still evidently in its favour; both portions were sown the same day. I certainly consider it a good artificial dressing, and that its fertilizing qualities are great."

URCEOLINA. A recently discovered genus of ornamental exotic plants, of the amaryllis order. The name alludes to the pitcher form of the flower. The pendulous species, *U. pendula*, has yellow and green flowers, and blooms in June, and was introduced to the greenhouses of Britain a few years ago from the Andes.

URE. The udder of a cow or ewe or other mammal. The word is provincial.

UREA. A chief and characteristic constituent of urine. It can be separated by a somewhat easy chemical process; and it forms into crystalline plates, which cross one another in various directions or assume the shape of four-sided prisms, and which are transparent, yellowish-white or almost colourless, and of a slight pearly lustre. It is viscid and difficult to cut; it has a faint fetid odour, similar to that of garlic or arsenic, and a strong and acrid taste, similar to that of ammoniacal salts; it leaves a sensation of coldness on the tongue, like that left by saltpetre; it attracts moisture from the atmosphere, and deliquesces into a thick brown fluid; it is very soluble in water, and evolves much cold during solution; it melts at a temperature of about 248° Fahr., and decomposes at a rather higher temperature, swelling up and evaporating with an insufferably fetid odour, and passing into carbonate of ammonia and cyanuric acid; it dissolves but does not decompose under the action of hydrochloric acid; and it effervesces and decomposes under the action of nitric acid, giving off nitrous, azotic, and carbonic acid gases, and leaving a residuum which is white and concrete, and which eventually shows traces of ammonia and prussic acid. It has a specific gravity of about 1·35; it consists of two equivalents of carbon, four of hydrogen, two of oxygen, and two of nitrogen; and it is the only animal compound, or animal organic secretion, which has yet been artificially formed. A pure aqueous solution of urea may be heated to the boiling point, or exposed to the atmosphere for several months, without undergoing any change; but an aqueous solution of it containing the other constituents of urine—in other words, aqueously diluted urine, or much more urine itself—decomposes by a temperature of 212 Fahr., or rapidly passes into putrefactive decomposition by exposure to the atmosphere, and is converted in either case almost wholly into carbonate of ammonia. A solution of soda, potash, lime, magnesia, or barytes also rapidly dissolves and decomposes urea, changing it principally into carbonate of ammonia. The decomposition of urea, in any ordinary way, therefore, whether as a constituent of urine or of guano or

of any other excrement, becomes a rich source of the nitrogenous element in the nutrition of plants. See the articles URINE, LIQUID MANURE, GUANO, and AMMONIA.

UREDO. A large genus of minute hypodermous fungi, of the eutophytous group, and coniomycetous tribe. Several species are identified with two of the worst corn diseases of our country; about 60 species produce on various plants of the gardens and wilds of Britain the diseases which are popularly called blight and rust and mildew; and many species occur in other countries, additional to those which occur in Britain. See the articles MILDEW, SMUT, and FUNGUS. Most of the species in Britain have either a brown, orange, or yellow colour; and the greater number appear and come to maturity in summer or the early part of autumn. Species of a pulverulent or finely powdery nature infest the leaves of ficaria, potentilla, bramble, and carex; species of a scattered nature infest the leaves of geranium, primrose, alchemilla, beet, armeria, hypericums, epilobiums, anthyllis, burnet, and various umbelliferæ; species of a spreading nature infest the leaves of polygonum, alchemilla, and various rosaceæ; species which grow in a spotted manner infest the leaves of sorrel, and various compositæ and scrophulariaceæ; species which grow in the manner of patches infest the leaves of sphondylium and the bean-plant; species which have the appearance of pustules infest the leaves of mint, luzula, and sallow; species which have a mottled appearance infest the leaves of sallow and rose; species which have a gyrose appearance infest the leaves of coltsfoot, mercury, and raspberry; species which have a bright or brilliant appearance infest the leaves of saxifrage, campanula, and purging flax; species which have a very minute appearance infest the leaves of dock, polygonum, vaccinium, oak, and equisetum; and species which have a different appearance from any of the preceding infest the leaves of common field thistle, willow, ragweed, rye, stinking iris, bellflower, periwinkle, cerastium, and various leguminosæ.

URENA. A genus of exotic plants, of the mallow family. Upwards of a dozen species,—some of them annuals, and others small evergreen shrubs,—some with leaves undivided or slightly three-lobed, and others with leaves deeply and sublobedly three-lobed or deeply and sublobedly five-lobed,—and most about 2 or 3 feet high, and carrying either red or purple or carmine-coloured flowers,—have been introduced to British gardens, principally from India and tropical America. The most interesting is the showy, *U. speciosa*, an evergreen shrub of about 3 feet high, carrying pink flowers in November, introduced in 1828 from Ava, loving a soil of sandy loam, and requiring to be propagated from cuttings.

URETERS. The ducts which convey the urine from the kidneys to the bladder. Those of the ox are considerably larger than those of the horse, and have a stronger internal membrane, and terminate nearer to the neck of the bladder and nearer to each other.

URETHRA. The membranous and muscular canal which conveys the urine from the bladder. In the male horse, it is of considerable length, but, though making a curvature in passing over the bones of the pubis, is seldom if ever obstructed; in the ox, it is at once long and narrow and curved, and is frequently obstructed by calculi; and in mares and cows, it is very wide and short, and easily admits of an artificial withdrawal of retained urine by means of introducing the finger and keeping the neck of the bladder open. See the articles CALCULUS and LITHOTOMY.

URIC ACID. See URATES.

URINARY CALCULI. See CALCULUS.

URINE. The excrementitious liquid which is separated by the kidneys and collected in the bladder and expelled through the urethra of animals. It does not serve any ulterior purpose in the animal economy; but it is entirely an excrement, and simply consists of substances which are not wanted in the system, and whose accumulation or retention would disturb the health or endanger or destroy the life. It therefore is exceedingly compound; and contains various saline principles, animal earths, and highly azotised peculiar principles; and is necessarily a very powerful fertilizer. It widely varies in composition in different species of animals, in different states of health, under different kinds of regimen, and according to the kind and quantity of liquid received into the stomach; and it widely varies, also, in comparative quantity within any given period, and in the comparative degree of its concentration or dilution. A normal or very healthy specimen of it from the human subject is transparent, limpid, and of an amber colour; and has a saline taste, and a specific gravity of about 1·03; and, while warm, emits a slightly aromatic and not disagreeable odour; and gives a red tint to litmus paper, evincing the presence of a free acid or of a super-salt; and, after standing a few hours, makes a perceptible deposit of insoluble matter, and throws up a scum or light floating cloud of mucus and of super-urate of ammonia. Most other urine, except such as is either very morbid or excessively diluted, possesses similar chemical characters, and has a thicker consistency than water, and ranges in specific gravity at from 1·005 to 1·033; and all urine, no matter how healthy, soon begins to putrefy on exposure to the atmosphere, becomes turbid and dark-coloured, emits first an urinous odour and afterwards an alkaline and very offensive fetor, loses its acid reaction, deposits the earthy phosphates, and gradually generates a large quantity of carbonate of ammonia; and it undergoes similar changes by continuous boiling, and owes them in either case principally to the decomposition of its urea. See

the article Urea. The study of the multitudinous, intricate, great, and widely diversified changes which are made on the normal chemical composition of human urine by jaundice, dropsy, diabetes, inflammatory affections, and more or less by almost all other diseases which in any way affect the blood or the intestinal secretions, is an interesting example of the application of chemistry to the pathology and the practice of medicine, and has of late years been prosecuted to limits which have afforded valuable instruction to even intelligent and highly experienced physicians; and the same kind of study might no doubt be pursued, with very eminent advantage, in veterinary medicine.

Urine is employed in making phosphorus, sal-ammoniac, and carbonate of ammonia; and is mixed with the earths and composts of nitre beds; and, in a putrid state, is very useful in scouring woollens. But its grand use is in the capacity of a manure; and here it is vastly more valuable than most small cultivators or even many intelligent farmers are at all aware. Several of the most distinguished agricultural chemists have estimated that 90·9 parts of cows' urine or 55·95 parts of human urine or 15·3 parts of horses' urine ought to produce as great fertilizing effects as 100 parts of ordinary farm-yard manure; and Liebig relates that one hundred parts of wheat grown on a soil manured with cow-dung afforded only 11·95 parts of gluten and 62·3 parts of amylin or starch, while the same quantity grown on a soil manured with human urine yielded the maximum of gluten, namely 35·1 per cent., or nearly three times as much as the other. And although the expense of collecting urine manure and of conveying it to the field is considerably greater than that of collecting and carrying farm-yard manure, yet the difference is more than counterbalanced by the general and uniform distribution of the fertilizing principles upon the soil. But we have elsewhere discussed the whole question of economizing and using urine as a fertilizer, either by itself, or in dilution with water, or in several methods of chemical preparation, or as a basis of compound liquid manures, or as an ingredient in solid or semifluid composts; so that, in the sequel of the present article, we need only to discuss separately the qualities of the chief kinds of urine which are at the farmer's command; and this we shall do principally with the aid of Dr. Sprengel's Essay on Animal Manures. See the articles Liquid Manure, Excrement, Manure, and Farm-Yard Manure.

The urine of cattle, when fresh, has a yellow colour, occasioned by a small quantity of resinous colouring matter; but on standing a longer time exposed to the air, it assumes a brown, and even, at last, a black colour. This is to be ascribed to the formation of humic acid, from the organic bodies which are passing into decomposition. In summer, fresh urine of cattle always contains a portion of ammonia, while in winter it does not possess a trace of it; hence we see that in hot weather the urea, which is the principal source of ammonia, undergoes decomposition while remaining in the animal body. Urine which has been exposed for a year and a half in contact with the air no longer contains any organic remains, but salts only, or mineral bodies dissolved in water; yet it is still endued with strong manuring properties. When urine is applied, in its fresh state, to living plants, it either speedily destroys them, or brings them into a sickly condition,—an effect resulting partly from the excess of caustic ammonia which it contains, and partly from the decomposition of the urea. We therefore allow the urine to become putrid before making use of it, in order that the urea may be decomposed, and the caustic ammonia converted into the state of carbonate, humate, or acetate of ammonia. The urine of oxen has already been many times chemically investigated; and its component parts are found naturally to vary, as in the case of solid excrementitious matter, according to the food given to the animal. Brande was the first who investigated it; and he found that 100 parts, by weight, were composed of 68 of water, 4 of urea, 4 of carbonate of ammonia, 6 of sulphate of potash, 15 of muriates of ammonia and lime, and 3 of phosphate of lime. This analysis, however, is certainly incorrect; for there is never found in urine which still retains urea, and has, accordingly, undergone only a partial putrefaction, an amount of 32 per cent. of solid matter. When urine, on the contrary, stands exposed for a long time in contact with the air, the amount of water it contains is diminished by evaporation, and the proportion of the solid matter becomes then naturally greater. Now, such urine may probably have been that which Mr. Brande examined. He has, however, overlooked many other bodies occurring in this fluid, particularly soda and lime. According to Sprengel's more careful analysis of the fresh urine of cows fed in a pasture abounding with good nourishing grass, several kinds of clover and vetch, a mixture of field fennel and plantain, much dandelion, hawkbit, and a great proportion of common daisy, 100,000 parts, by weight, were found to be composed of 92,624 of water, 4,000 of urea, along with some resinous colouring matter, 10 of albumen, 190 of mucus, 90 of benzoic acid or hippuric acid, 516 of lactic acid, 256 of carbonic acid, 205 of ammonia, 664 of potash, 554 of soda, 405 of sulphuric acid, 70 of phosphoric acid, 272 of chlorine, combined with soda, lime, and magnesia, forming salts, 65 of lime, 36 of magnesia, 2 of alumina, 4 of oxide of iron, 1 of oxide of manganese, and 36 of silica. But all the acids and the chlorine were in combination with the alkalies and the alkaline earths, forming salts. Cattle urine contains in winter very much less, often scarcely half the quantity of urea found in Sprengel's

analysis, and is then, of course, much less valuable as manure. It also contains less manuring matter the more water the cows drink,—a circumstance to which attention must be paid. In summer, it passes very quickly into a state of putrefaction, and much ammonia is consequently developed in the form of gas; likewise carbonic acid, and a portion of sulphuretted and phosphuretted hydrogen, which likewise partly assume the gaseous state. The last two gases are the cause of the intolerable odour of putrefying urine. The caustic ammonia arising in every case from the decomposition of the urea and the other organic bodies of urine which contain nitrogen remains partly dissolved in water, and is the substance through which urine not properly putrefied is so apt to injure plants. If, on the contrary, the urine remains a long time exposed to the air, the caustic ammonia absorbs from it carbonic acid, becomes mild, and the urine may then be employed without danger as a manure for vegetation. That the putrefied urine actually contains much carbonic acid combined with the ammonia, we find by mixing it with mineral acids, when strong effervescence ensues. Another analysis by Sprengel of cattle urine which had been exposed to the air for a month to putrefy, and had lost very little by evaporation, exhibited the following as the composition of 100,000 parts by weight:—95,442 of water, 1,000 of urea, along with a portion of resinous colouring matter, 0 of albumen, 40 of mucus, 250 of benzoic or hippuric acid, 500 of lactic acid, 1 of acetic acid, 165 of carbonic acid, 487 of ammonia, occurring partly in an uncombined state, 664 of potash, 554 of soda, 338 of sulphuric acid, 26 of phosphoric acid, 272 of chlorine, 2 of lime, 22 of magnesia, 1 of sulphuretted hydrogen, 5 of silica, 1 of oxide of iron, and 180 of sediment consisting of phosphate and carbonate of lime and magnesia, alumina, silica, and oxide of iron, and oxide of manganese. Thus, if the urine of cattle, which has been putrefying for a month, contains more than as much again of ammonia as urine in its fresh state, it would obviously have contained a still greater proportion if some of it had not evaporated during the time; and that this escape of the gas actually did take place was made evident, not only from the smell, but also on the application of chemical tests,—for instance, by holding muriatic acid near it, when a dense white vapour of sal-ammoniac, in every case, immediately ensued. The ammonia, which escapes in the form of gas, naturally occasions a direct and not inconsiderable loss of that element to which the putrefying urine owes its principal action as a manure; so that it is of importance to add to the decomposing urine some substance containing an acid principle, which not only combines with the ammonia as it becomes gradually developed, but also neutralizes it. See the article Liquid Manure.

When cattle urine is left for three months or longer in the tank, a considerable portion of the carbonate of ammonia formed in it is lost, for the carbonate evaporates as well as the caustic ammonia, though more slowly. A small quantity of carbonate of ammonia is also continually evaporating from urine even when mixed with water; and therefore when the caustic ammonia has been rendered mild by its conversion into carbonate, no time should be lost in applying it as a manure to growing plants. The escape of the volatile ammonia, however, is prevented the most completely when the urine is mixed with humus, and then either left to putrefy or laid on the field and immediately ploughed in. Urine, five or six months old, contains not a trace of its original urea, mucus, and albumen; on the other hand, there are found in it carbonate, sulphate, and humate of ammonia, humates of lime and magnesia, common salt, and also some benzoate, lactate, and acetate of ammonia. The lactic, acetic and benzoic or hippuric acids, belonging to the class of organic bodies, do not injure vegetation, being united to the ammonia, and therefore in some measure incorporated as inorganic matters.—If urine has not been mixed with water, and contains a certain quantity of solid excrement, it is said to be a sign that it has acquired its proper maturity in the tank when no further scum or froth arises to the surface even when the liquid is stirred up. No doubt, this is a certain proof that the fermentation of the urine is completed, and that it may now be applied without injury to growing vegetables; for the scum, or bubbles, are occasioned by the carbonic acid, which cannot even begin to escape until it has saturated all the ammonia present. Still, although urine which froths no longer contains caustic ammonia, and consequently is no longer injurious to vegetable life—how much ammonia up to the moment when this is the case has escaped in the form of gas, and how much of the choicest manuring element has been up to that point lost by the urine! On this consideration we should at once hasten to convey the urine as fresh as possible to the field, but to a field which has no crop on it. In fact, whoever is obliged, for want of straw, to collect the urine separately,—whoever, if he be compelled to do this, mixes no water with it, or who fails also to employ some neutralizing substance to combine with the ammonia which is produced in so great a degree during the summer, suffers a loss of manure which exceeds all belief! It is indeed only a gaseous substance, and not a solid material visible to the eye, which thus escapes and is lost; but for all that it is of greater importance to the nourishment of plants than perhaps any other portion of the excrements.

Sheep drink very little water, and therefore void comparatively little urine; yet even when they take no drink whatever, the water of their urine and that found in their solid excrements

is greater in amount than what existed originally in their food; so that as they likewise breathe out water in the form of vapour from their lungs, and evaporate it through the skin, they must produce water chemically from oxygen and hydrogen during the process of digestion. Their urine, on account of its small amount, is never collected and used by itself, but is always taken up by the litter, and applied to the land along with the solid excrements; and though not belonging to circumstances to which much attention is devoted in agriculture, it is nevertheless interesting to learn its component parts. Sprengel several times submitted it to a superficial chemical analysis, and found that it is more abundant in salts than the urine of the cow, without, however, containing so many substances possessing nitrogen; and that 100,000 parts by weight of the fresh urine of sheep kept at grass, and which, when tested, was found to indicate neither acid nor alkaline properties, contained 96,000 parts of water, 2,800 of urea, along with some albumen and colouring matter, and 1,200 of salts of potash, soda, lime, and magnesia, with traces of silica, alumina, iron, and manganese. Sheep urine, therefore, contains 4 per cent. more water than cattle urine; but possessing a tolerable quantity of urea, it passes quickly into decomposition, and developes, in consequence, much ammonia,—a fact which explains the occurrence of the strong ammoniacal smell in the places where sheep are kept; this smell being much increased, however, by the ammonia likewise produced in the decomposition of the solid excrements, which contain much nitrogen, and by the exhalation of a certain degree of ammonia through the skin of the sheep. The ammonia thus formed naturally evaporates the sooner when the manure is deficient in moisture, which would retain it. Hence it is obvious how great a quantity of the ammonia of this very valuable manure is lost in the ordinary management of the dung when sheep are kept in houses.

Horses drink less water than cattle; and as they lose at the same time much moisture by evaporation through the skin, they also discharge much less urine. According to Fourcroy and Vauquelin, their urine contains 94 per cent. of water, 0·7 of urea, 2·4 of benzoate of soda, 0·9 of carbonate of soda, 1·1 of carbonate of lime, and 0·9 of muriate of potash. This analysis, however, as can be easily proved, is not quite correct; for it ought to comprise small proportions of mucus, albumen, magnesian salts, phosphate of lime, colouring matter, and some other less important substances. Since horse urine contains much less nitrogenous matter than cattle urine, it has much less value as a manure; and on account of its small amount it is never worth the trouble of being collected and employed by itself, but is brought to the soil in mixture with the solid excrement and litter. The circumstance of the urine of the horse containing so few substances united with nitrogen explains to us how it happens that in the solid excrements there are found so many of these bodies. The nitrogen derived by the body from the food is again, however, partly lost by evaporation through the skin, combined with hydrogen, and forming ammonia; the perspiration of the horse always having, from this cause, an ammoniacal odour.

The urine of hogs is more copious than that of any other domesticated animals, in consequence of their using a comparatively large quantity of liquid food; and it acquires in putrefaction the most intolerable odour, occasioned by a peculiar volatile substance, at present imperfectly known; and it is this substance probably which communicates the unpleasant flavour to esculent roots. According to Sprengel's investigation, 100,000 parts, by weight, of the urine of pigs fed on corn offal, consisted of 92,600 of water, 5,640 of urea, with a very little mucus, albumen, and colouring matter, and 1,760 of salts, as common salt, muriate of potash, gypsum, carbonate of lime, and sulphate of soda. It results from this analysis, that the urine of the pig contains rather a smaller proportion of water than the urine of cattle, and $1\frac{1}{2}$ per cent. more of urea; and this circumstance perfectly explains the reason of its being more caustic in its fresh state than that of cattle, a larger supply of ammonia being created out of the greater amount of urea; so that before the urine of the pig can be applied with propriety to growing plants, it must have undergone putrefaction. To prevent, however, an useless escape of the ammonia, it will be very advisable to dilute it with a good deal of water before exposing it to putrefy, or to proceed with it as already recommended in the case of cattle urine. The ill effects of pig urine, not properly putrefied, are commonly ascribed to the presence of a peculiar acidity; but they arise from no other cause than the caustic ammonia. When this urine is conducted, as is generally the case, into the manure pit, a great loss of manuring matter, in the form of gas, always takes place; and it is, therefore, the best plan to convey it by itself into a tank, and mix it with a large quantity of water. For this plan, however, a judicious arrangement of the sty is necessary; and, if situated near the cattle-stalls, the urine of the pig can be led to that of the cattle, and there allowed to putrefy. It is maintained that, when the urine of the pig gets into a pond containing fish, it kills them: should this actually be the case, the effect would probably be occasioned by sulphuretted hydrogen, resulting from the decomposition of gypsum, and constituting a gaseous poison, to the action of which fishes are very sensible, and of which a very small quantity is required to kill them instantly.

Human urine contains rather more water than that of cattle; and as it also holds less urea and

other manuring elements, it is not quite so valuable. It has often been the subject of most accurate chemical investigations for medical and pathological objects; and these investigations are available for the farmer, showing as they do the value of this fluid for agricultural purposes, and how it must be treated in order to derive from it the greatest possible advantage. In the vicinity of great cities, it is always to be had at a cheap rate and in great quantities. According to the investigations of Berzelius—who does not, however, state the kind of food taken—100·000 parts by weight of human urine contain 93·300 of water, 3·010 of urea, 1·714 of salivary matter, osmazome, lactic acid, and lactate of ammonia, 0·032 of mucus of the bladder, 0·100 of uric acid, 0·165 of phosphate of ammonia, 0·150 of muriate of ammonia, 0·371 of sulphate of ammonia, 0·316 of sulphate of soda, 0·445 of common salt, 0·294 of phosphate of soda, 0·100 of phosphates of lime and magnesia, with a trace of fluate of lime, and 0·003 of silica. Besides these substances, certain portions of the following have also been found in human urine,—albumen, gelatine, a resinous substance, colouring matter, fat, acetic, benzoic, and carbonic acids, sulphuretted hydrogen, muriate of lime, and oxide of iron. It passes like the urine of other animals into rapid decomposition, developing much ammonia. It would therefore be very injudicious not to take care to secure the ammonia in combination, as in the case of cattle urine; and this may be accomplished either by dilution with water, or by the addition of sulphuric acid, sulphuric acid salts, or humic acid. Mixture with earth abounding with humus, when such earth can be obtained, is always the best; and for this purpose the earth may be laid in heaps, and the urine poured over them until the whole of the humic acid is neutralized by the ammonia which forms, —a point which can easily be ascertained by the smell, for when neutralized, the ammoniacal smell is immediately perceived. The heaps should be frequently turned over and loosened, for the purpose of allowing the water to drain away. We may proceed in the same manner with cattle urine, and so obtain a manure, surpassing in its quality the best preparation of dung. In its unputrefied state, or at least so long as it still contains caustic ammonia, human urine cannot be applied with more impunity than cattle urine to green plants, as it immediately kills them, unless the soil should happen to abound with humic acid. If, therefore, we have no opportunity of allowing it to putrefy in mixture with some soil rich in humus, it can be applied only to the manuring of fields which have no crops growing on them.

URINE (Bloody). See Redwater.

URINE (Excessive Discharge of). See Diabetes.

URINE (Incontinence of). A continual dropping of urine, occasioned by the debilitated state of the neck of the bladder and of the bladder itself. The most frequent cause of it is excessive and prolonged distension of the bladder by excessive accumulation of urine, putting the muscular fibres of the bladder so severely on the stretch as permanently to weaken them, or to deprive them of their contractility. In the case of the horse, the best remedy, probably, is to turn him to grass; and when this cannot be done, he should be kept in a loose box on green food or on a moderate quantity of hay and water, and some bran mashes or a mixture of bran and oats. The only medicine likely to be serviceable to him is an iron tonic, accompanied in bad or obstinate cases with some tincture of cantharides.

URINE (Retention of). A want of power to evacuate urine. It arises either from loss of contractility in the muscular fibres of the bladder, or from inflammation or some other disease of the neck of the bladder. In the horse, it is occasioned sometimes by riding him for a considerable time and urging him forward, without allowing him opportunity to stale,—and sometimes by working him unduly hard, or not allowing him sufficient repose, or not affording him additional and frequent opportunities to stale, after having given him a diuretic ball. It may be ascertained to exist in the horse by introducing the hand within the rectum, and feeling the bladder to be distended. Everything must be avoided which tends to increase the secretion of urine; and if any degree of fever be present, blood must be taken and a dose of castor oil and a laxative glyster given; and if relief be not speedily enough obtained by these means, the urine must be artificially drawn off,—in the case of a mare, by introducing the finger or a short tube into the urethra and holding open the mouth of the bladder,—and in the case of a male horse, by passing a long, smooth, cylindrical piece of whalebone up the urethra as far as it will readily go, making an incision where the end of it is felt a few inches under the fundament, and through this incision introducing a catheter. A ball of opium, saltpetre, and camphor, in due quantities and proportions, mixed up with flour and syrup, may now be given; and, for some days, very little water must be allowed, and everything of a diuretic kind carefully avoided.

URINE (Suppression of). The partial or total cessation of the proper functions of the kidneys, so that very little urine or none is secreted. It arises sometimes from torpor in the kidneys, sometimes from inflammation in them, and sometimes from a gradual decay of their structure. See the articles Inflammation and Kidney. Gradual decay of the kidneys of the horse arises sometimes from the carrying of heavy loads, but more commonly from the improper use of strong diuretics; and is not indicated by any particular symptoms till it has made considerable progress; and then shows

itself by occasional retentions of urine, and by eruptions on different parts of the body; and, when it advances so far as to put a complete end to secretion, the animal soon dies.

UROPETALON. A genus of exotic, ornamental, bulbous-rooted plants, of the asphodel order. The name signifies 'tailed petal,' and is descriptive. Six species, varying in height from 8 to 24 inches, and mostly carrying greenish flowers in the latter part of summer, have been introduced to British gardens, principally from Africa; and they require frame or greenhouse protection; and love a soil of loamy peat, and are propagated from offsets.

URRY. A sort of blue or black clay, lying near a vein of coal.

URTICA. See Nettle.

URUS. See Ox.

URVILLÆA. A genus of ornamental, tropical, climbing plants, of the soap-berry family. Two species, the elm-like and the rusty, both white-flowered, and between 20 and 30 feet high, have been introduced to British gardens from South America; and they thrive best in a soil of sandy peat, and are propagated from cuttings.

USNEA. A genus of lichens, of the homothalamous tribe. Three species, varying in height from 2 to 4 inches, and all having a greenish colour, flourishing in winter, and inhabiting old trees, are indigenous in Britain; and one of these, *U. plicata*, of a pendulous habit, comprising a hairy variety, *U. p. hirta*, of a nearly erect habit, is sometimes used as a dye-stuff.

USTILAGO. A genus of minute fungi,—hypodermous, eutophytous, and coniomycetous,—nearly allied to the uredines. They have a burned or scorched appearance, and were originally identified with the cereal disease called burnt-ear, and may be regarded as more truly allied to smut than even any strict uredo. Five species occur in Britain; and infect the grains of wheat, the grains of barley, the fructification of some of the carices, and the herbage of the corn-field scabious and of various caryophylleaceæ; and they have either a black or otherwise very dark colour; and in most instances, make their appearance and come to maturity in the latter part of summer. See the articles Mildew, Smut, Fungus, and Uredo.

UTERUS. See Womb.

UTRICULARIA. See Hooded Milfoil.

UVARIA. A genus of ornamental, tropical, evergreen, ligneous plants, of the custard-apple family. Seven or eight species, chiefly erect shrubs of about 6 feet in height, but one a twiner of about 20 feet in height, have been introduced to British gardens from India; and they love a soil of peaty loam, and are propagated from cuttings. Most have brownish coloured flowers; and they take their name of uvaria from the circumstance of their fruit having some resemblance to bunches of grapes.

UVA URSI. See Arbutus.

UVULARIA. A genus of ornamental, hardy, perennial-rooted, annual-stemmed, North-American, herbaceous plants, of the melanthium family. Six species, varying in height from 6 to 15 inches, and chiefly carrying yellow flowers in May and June, have been introduced into Britain; and all love a soil of peaty loam, and are propagated from suckers. The earliest introduced may serve as a specimen of the whole. Its root comprises many thick fleshy fibres, and sends up several stems; its stems, for the most part, divide into two at a small height from the ground, and spread asunder; its leaves are connate, or surround the stem in a manner as if it went through them, and are broad-based, oblong, pointed, and smooth; and its flowers come out on slender footstalks from the bosom of the leaves, and hang downward, and comprise each six oblong, acutely pointed, yellow petals.

V

VACCINATION. See Cow-Pox.

VACCINIUM. A genus of ornamental, calyciflorous, ligneous plants, constituting, with the genus oxycoccus, the natural order Vaccinieæ. This order is nearly allied to the heaths; and is characterised principally by its inferior berry; and is diffused, in its natural state, throughout a large portion of Europe, Asia, and North America. Only four of its species belong to the genus oxycoccus. But two species of the genus vaccinium grow wild in Britain, nearly fifty have been introduced from other countries, and a few more are known. Two or three of the vacciniums in Britain are tender evergreen shrubs, a few are hardy evergreen undershrubs, and all the rest are hardy deciduous undershrubs, shrubs, or small trees. Several possess considerable reputation and value for sake of their esculent fruit; and almost all are beautiful or more or less elegant. Two or three of the best known are described in the articles Cowberry, Whortleberry, and Myrtle Bilberry. The majority thrive

best in a soil of peat, and the rest in a mixture of peat and loam. One or two are propagated most readily from cuttings, three or four from suckers, and all the rest from layers.

The most interesting, additional to those noticed in other articles, are the diffuse, *V. diffusum*, a hardy deciduous tree of about 20 or 25 feet in height, carrying pink flowers from May till July, and introduced from Carolina in 1765; the bear's grape, *V. arctostaphylos*, a hardy deciduous shrub of 10 or 12 feet in height, carrying white flowers from April till June, and introduced from Caucasus in 1800; the bushy, *V. dumosum*, a hardy deciduous shrub, of 3 or 4 feet in height, carrying white flowers in May and June, and introduced from North America in 1774; the pleasing, *V. amœnum*, a hardy deciduous shrub, of 6 or 8 feet in height, carrying white flowers in May and June, and introduced from North America in 1765; the Maryland, *V. marianum*, a hardy deciduous shrub, of about 2 feet in height, carrying white flowers in May and June, and introduced from Maryland in 1812; the Pennsylvanian, *V. pennsylvanicum*, a hardy deciduous fruiting undershrub, of about 20 inches in height, carrying white and blush flowers in May and June, and introduced from North America in 1772; the narrow-leaved or myrtle-like, *V. angustifolium*, a hardy deciduous small shrub, of about 2 feet in height, carrying pink flowers in April and May, and introduced from North America in 1776; the Madeira, *V. madeirense*, a hardy deciduous fruiting shrub, of 6 or 7 feet in height, carrying red and green flowers from June till August, and introduced from Madeira in 1777; the beautiful, *V. venustum*, a hardy deciduous shrub of about 3 feet in height, carrying pink flowers in May and June, and introduced from North America in 1770; the corymbose, *V. corymbosum*, a hardy deciduous shrub of about 8 feet in height, carrying white flowers in May, and introduced from North America in 1806; the glossy, *V. nitidum*, a hardy evergreen undershrub of about 20 inches in height, carrying pink flowers in May and June, introduced from Carolina in 1794, and comprising a decumbent variety, *V. n. decumbens*, of about only one half its own height; the frondose, *V. frondosum*, a hardy deciduous shrub of about 3 feet in height, carrying white and green flowers in May and June, and introduced from North America in 1761; the pale, the long-stemmed, and the white-flowered, *V. pallidum*, *V. stamineum*, and *V. album*, hardy deciduous small shrubs, about 2 feet high, carrying white flowers in May and June, and introduced from North America in 1772; the twiggy, *V. virgatum*, a hardy deciduous shrub, about 3 feet high, carrying pink flowers in April and May, introduced from North America in 1767, and comprising a variety, *V. v. angustifolium*, with narrow leaves and white flowers; the resinous, *V. resinosum*, a hardy deciduous shrub, 3 or 4 feet high, carrying purple and green flowers in May and June, introduced from North America in 1772, and comprising three varieties, with viridescent, rubescent, and yellowish flowers; the myrsine-leaved, *V. myrsinites*, a hardy evergreen undershrub, about 20 inches high, carrying pink flowers in May and June, introduced from Florida and Carolina, and comprising two varieties with respectively lanceolate leaves and obtuse leaves; the myrtle-leaved, *V. myrtifolium*, a slightly tender evergreen trailer, about 10 or 12 inches high, carrying white flowers from May till July, and introduced from Carolina in 1812; the earth-spread, *V. humifusum*, a hardy, very handsome, very small evergreen trailer, only 2 or 3 inches high, carrying white flowers in May, and introduced from the Rocky Mountains in 1827; and the meridional, *V. meridionale*, a tender evergreen small shrub, about 2 feet high, carrying white and green flowers from March till June, and introduced from Jamaica in 1778.

VAGS. Turfs cut and dried for fuel. The word is provincial.

VALANTIA. A genus of hardy herbaceous plants, of the madder family. The crosswort species, *V. cruciata*—called by some botanists *Galium cruciatum*,—is a perennial-rooted, trailing native of Britain, about 15 or 20 inches high, carrying yellow flowers in May and June. Five annual species, and five perennial-rooted trailing ones, all with flowers of more or less of a herbaceous colour, have been introduced to Britain principally from Continental Europe; but they do not possess much interest, otherwise than as being near akin to the bedstraws and the true madders.

VALERIAN,—botanically *Valeriana*. A genus of ornamental, calyciflorous, herbaceous plants, constituting the type of the natural order Valerianaceæ. This order is intermediate in botanical character between the teazel and the madder families; and consists of small, neat, symmetrical herbs, many of which are more or less suitable for the parterre, and some useful for either culinary or medicinal or economical purposes. One or two greenhouse species and upwards of 50 hardy ones, belonging to the genera valeriana, valerianella, patrinia, fedia, and centranthus, occur at present in British collections. Three indigenous species, nearly 20 introduced exotic species, and about 50 known unintroduced species belong to the valerian genus; and excepting one biennial and one tuberous-rooted perennial, all the introduced species are fibrous-rooted, annual-stemmed perennials. Most thrive well in any common soil; and all are propagated by division of the plant.

The officinal valerian, or great wild valerian, *V. officinalis*, is a perennial-rooted, annual-stemmed indigen of many parts of Britain. One variety of it inhabits woods and marshy grounds, and another inhabits high pastures and heaths; and the latter is superior to the former in medicinal power. The roots comprise long and slender

fibres issuing from heads; the stems are cylindrical, grooved, hollow, and 3 or 4 feet high, and terminate in flowering branches disposed crosswise; the leaves are opposite, connate, pinnate, bearded at the base below, largest at the bottom of the stem, and of decreasing size toward the summit; the leaflets are serrated, deeply veined, dark green above, and paler below, and the terminal one is a little larger than the rest; the flowers grow in corymbs, and are small, odorous, and interspersed with lanceolate, bearded, pale bracts, and have a flesh-coloured tubular corolla, with five reflected, obtuse, marginal segments, and bloom in June and July; and the capsule is crowned with feathery down, and contains one oblong-ovate, compressed seed. The root is the part used in medicine; and is best in plants which grow wild on calcareous soil; and should be dug up at some time during the autumnal and hybernal repose of the plant. It loses three-fourths of its weight by drying. It has a warm, bitter, subacrid taste, and a strong, peculiar odour, which is highly attractive to cats, but decidedly unpleasant to most human beings. It contains gum, starch, extractive, resin, a very thin greenish-white volatile oil, and a large proportion of woody fibre; it surrenders its active matter to alcohol, boiling water, and solution of the pure alkalies; and it is converted by a small dose of nitric acid into resin, and by a larger one into oxalic acid. It possesses antispasmodic, tonic, and emmenagogue properties; and acts well upon the human subject in cases of hysteria, hemicrania, hypochondriasis, symptomatic epilepsy, and other affections connected with morbid nervous susceptibility; but it is of little use to the farrier, except perhaps as an antispasmodic,—and not of much in even that capacity.

The dicœcious or small marsh valerian, *V. dioica*, is a perennial-rooted indigen of marshes and moist boggy meadows in many parts of Britain. Its stem is from 6 to 12 inches high; its leaves are entire; and its flowers are flesh-coloured, and have short blunt spurs, and bloom from May till July.

The Pyrenean or heart-leaved valerian, *V. pyrenaica*, is a perennial-rooted indigen of woods in various parts of Scotland. Its stem is furrowed and about 3 feet high; its cauline leaves are heart-shaped and serrated,—and the upper ones stand on downy foot-stalks; and its flowers are flesh-coloured or light rose-coloured, and have short spurs, and bloom in May and June. Its odour is similar to that of the officinal species.

The jatamansi valerian, *V. iatamansi*, a native of the mountains of Nepaul, is thought by some distinguished oriental botanists to be the precious spikenard of the ancients. Its root is fusiform, and about the thickness of the human finger, and bears on its upper part articulations so covered with dense fibres as to have somewhat the appearance of the tails of animals.

VALERIANELLA. See Lamb's Lettuce.

VALERIAN (Greek.) See Greek Valerian.

VALLESIA. A genus of ornamental, tropical, ligneous plants of the dog's bane family. Two species,—both white-flowered, summer-blooming, evergreen shrubs of about 3 feet in height,—have been introduced to British collections from tropical America.

VALLISNERIA. A genus of curious, floating aquatic plants, of the hydrocharis family. The spiral species, *V. spiralis*, is a native of the Rhone and of other rivers in Southern France and in Italy, and was introduced about 30 years ago to the botanical collections of Britain. It exhibits, in a very manifest and somewhat unique way, one of those exquisite contrivances which exist by the million in every department of creation, and evince the surpassing wisdom and provident care and infinite intelligence of the Almighty. It carries a large heavy flower, which requires always to float on the surface of the water, and would speedily perish either if much submerged or if left dry or pendulous; and it at the same time inhabits streams which are subject to great and sudden changes of volume, often alternately rising several feet above and falling several feet below their ordinary dimensions. The stem of the plant, therefore, though slender, is very long and of a spiral or cork-screw form, and so highly flexible as very easily to extend or contract; and it so readily and uniformly lengthens with the rise of the water and shortens with its fall, that the head or flower constantly and neatly lies on the surface.

VALLOTA. An ornamental, bulbous-rooted, South-African plant, of the amaryllis family. It was introduced to the greenhouses of Britain about 75 years ago; and it formerly ranked as a true amaryllis; but it now constitutes a genus of itself with the specific name of *purpurea* or the purple. It has a height of about 20 inches, and carries scarlet flowers in May and June; but it comprises a smaller variety, *V. p. minor*, of little more than half the height of the normal plant. It thrives best in a mixture of peat and sand.

VALONIA. A kind of acorn, used by tanners and dyers, and forming a very considerable article of export from the Morea and the Levant. It has a bright drab colour, and maintains this as long as it is kept dry; but it turns black when exposed to moisture, and is then so injured as to lose much of its strength and value. The more substance it has in its husk or cup it is the more valuable. Though a bulky article, it is always estimated and bought and sold by weight. In 1838, between 70 and 80 tons of it were imported into Britain.

VALUATION. See Lease and Tenant-Right.

VALUATION OF TIMBER. As all timber is sold by the cube foot, this price of course regulates the price of all scantling; consequently if we calculate how much of any sized scantling will make a cube foot, and add the price of saw-

ing, we shall at once determine the value of such scantling. This calculation is simple and easy, but it occurs so frequently, and for such a variety of sizes, that the following table, in which the quantities are shown on inspection, will be very useful.

A TABLE showing what length of timber of any scantling from 2 inches to 12 inches square, will make a cube foot of timber.

In.	*In.*	*Ft.*	*In.*
2 by	2 requires	36	0
2 „	2½ in length	28	9
2 „	3	24	0
2 „	3½	20	7
2 „	4	18	0
2 „	4½	16	0
2 „	5	14	5
2 „	5½	13	1
2 „	6	12	0
2 „	6½	11	1
2 „	7	10	3
2 „	7½	9	7
2 „	8	9	0
2 „	8½	8	6
2 „	9	8	0
2 „	9½	7	7
2 „	10	7	3
2 „	10½	6	10
2 „	11	6	6
2 „	11½	6	4
2 „	12	6	0
3 „	3	16	0
3 „	3½	13	8
3 „	4	12	0
3 „	4½	10	8
3 „	5	9	7
3 „	5½	9	0
3 „	6	8	0
3 „	6½	7	4
3 „	7	6	10
3 „	7½	6	4
3 „	8	6	0
3 „	8½	5	8
3 „	9	5	4
3 „	9½	5	0
3 „	10	4	10
3 „	10½	4	6
3 „	11	4	4
3 „	11½	4	2
3 „	12	4	0
4 „	4	9	0
4 „	4½	8	0
4 „	5	7	2
4 „	5½	6	6
4 „	6	6	0
4 „	6½	5	6
4 „	7	5	1
4 „	7½	4	9
4 „	8	4	6
4 „	8½	4	3
4 „	9	4	0
4 „	9½	3	9
4 „	10	3	7
4 „	10½	3	5
4 „	11	3	3
4 „	11½	3	2
4 „	12	3	0
5 „	5	5	9
5 „	5½	5	3
5 „	6	4	10
5 „	6½	4	5
5 „	7	4	1
5 „	7½	3	10
5 „	8	requires 3	7
5 „	8½	in length 3	5
5 „	9	3	2
5 „	9½	3	0
5 „	10	2	10
5 „	10½	2	9
5 „	11	2	8
5 „	11½	2	6
5 „	12	2	4
6 „	6	4	0
6 „	6½	3	8
6 „	7	3	5
6 „	7½	3	2
6 „	8	3	0
6 „	8½	2	10
6 „	9	2	8
6 „	9½	2	6
6 „	10	2	5
6 „	10½	2	3
6 „	11	2	2
6 „	11½	2	1
6 „	12	2	0
7 „	7	2	11
7 „	7½	2	9
7 „	8	2	6
7 „	8½	2	5
7 „	9	2	3
7 „	9½	2	2
7 „	10	2	1
7 „	10½	1	11
7 „	11	1	10
7 „	11½	1	9
7 „	12	1	8
8 „	8	2	3
8 „	8½	2	1
8 „	9	2	0
8 „	9½	1	10
8 „	10	1	9
8 „	10½	1	8
8 „	11	1	7
8 „	11½	1	7
8 „	12	1	6
9 „	9	1	9
9 „	9½	1	8
9 „	10	1	7
9 „	10½	1	6
9 „	11	1	5
9 „	11½	1	5
9 „	12	1	4
10 „	10	1	4
10 „	10½	1	4
10 „	11	1	4
10 „	11½	1	3
10 „	12	1	2
11 „	11	1	2
11 „	11½	1	2
11 „	12	1	1
12 „	12	1	0

A TABLE for expeditiously measuring round timber.

Quarter girt.	Area.	Quarter girt.	Area.	Quarter girt.	Area.
Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
6	0·250	12	1·000	18	2·250
6¼	·272	12¼	1·042	18½	2·376
6½	·294	12½	1·085	19	2·506
6¾	·317	12¾	1·129	19½	2·640
7	0·340	13	1·174	20	2·717
7¼	·364	13¼	1·219	20½	2·917
7½	·390	13½	1·265	21	3·062
7¾	·417	13¾	1·313	21½	3·209
8	0·444	14	1·361	22	3·362
8¼	·472	14¼	1·410	22½	3·516
8½	·501	14½	1·460	23	3·673
8¾	·531	14¾	1·511	23½	3·835
9	0·562	15	1·562	24	4·000
9¼	·594	15¼	1·615	24½	4·168
9½	·626	15½	1·668	25	4·340
9¾	·659	15¾	1·722	25½	4·516
10	0·694	16	1·777	26	4·692
10¼	·730	16¼	1·833	26½	4·876
10½	·766	16½	1·890	27	5·062
10¾	·803	16¾	1·948	27½	5·252
11	0·840	17	2·006	28	5·444
11¼	·878	17¼	2·066	28½	5·640
11½	·918	17½	2·126	29	5·840
11¾	·950	17¾	2·187	29½	5·944
				30	6·250

EXAMPLE OF THE USE OF THE ABOVE TABLE.

Having taken the quarter girt of any piece of timber by measurement, find the corresponding quarter girt in the table, and the number in the column headed 'area' that stands opposite being taken out, is to be multiplied by the length of the tree in feet, and the product will be the contents in cubic feet and decimals of a foot. Thus suppose a piece of timber 16 feet 9 inches long, (or 16·75 feet,) and its quarter girt to be 20 inches; its corresponding area is 2·717, therefore $2{\cdot}717 \times 16{\cdot}75 = 45{\cdot}50975$ feet the contents.

VANADIUM. One of the rare metals. It was not discovered till 1830; but was then discovered by two mutually independent parties, in the iron ore of Tuberg in Sweden and in a peculiar mineral at Wanlockhead in Scotland. It has a strong metallic lustre and a somewhat silver-like appearance, but is so extremely brittle that it cannot be removed from the position in which it is obtained in its separate or proper state without falling into powder. It is insoluble in boiling sulphuric, hydrochloric, or hydrofluoric acid; but it dissolves in nitric or nitromuriatic acid, and gives the solution a beautiful dark blue colour. It combines in three proportions with oxygen, forming a protoxide, a binoxide, and an acid; and it combines also with chlorine, bromine, sulphur, and phosphorus. Vanadic acid is the most important of the compounds; and has a light rust-yellow colour in the state of fine powder, and a reddish colour with a shade of orange and a strong lustre in a state of fusion; and is tasteless and insoluble in alcohol and very slightly soluble in water; and combines somewhat in the manner of a base with sulphuric, phosphoric, and phosphoro-silicic

acids; and unites, in its proper capacity of an acid, with salifiable bases, often in two or more proportions, forming soluble salts with the alkalies, and in general sparingly soluble salts with the other metallic oxides.

VANDA. A genus of ornamental, tropical plants, of the orchis family. Eight or nine species, chiefly epiphytes, varying in height from 8 to 25 inches, were introduced to Britain, principally from China, within the first 35 years of the present century. Three of the most handsome are the many-flowered, *V. multiflora*, two feet high, carrying yellow flowers in June; the taper-leaved, *V. teres*, two feet high, carrying pale yellow flowers in June; and Roxburgh's, *V. Roxburghi*, 18 inches high, carrying white and purple flowers in November, and comprising one variety with whole colour, and another with tesselated sepals and petals. See the article Orchis.

VANGUIERA. A genus of curious, exotic, evergreen shrubs, of the madder family. The eatable species, *V. edulis*, is a native of India, and was introduced thence about 40 years ago to the botanical collections of Britain. It ranks, in the estimation of the Hindoos, as a fruit shrub; and it has naturally a height of between 12 and 20 feet. Two species, 3 or 4 feet high, have been introduced from Madagascar.

VANILLA. A genus of ornamental, economical, tropical plants of the orchis family. Two climbing species, the smooth-leaved and the aromatic,—and one epiphytous species, the two-coloured,—have been introduced to British hothouses from tropical America; and all, inclusive of a number of varieties, are remarkable for the fragrance of their fruit or pods, but cannot, without difficulty, be made to thrive and still less to fructify under artificial European culture. The fruit of the most common varieties has long been assiduously gathered in their native regions, and exported thence to Britain and other countries, as an esteemed ingredient for flavouring or perfuming ices, creams, chocolate, snuff, hair-oils, fine unguents, and other preparations. "The plant which produces the fruit called vanilla," says Miller, "hath a trailing stem, somewhat like common ivy, but not so woody, which fastens itself to whatever tree grows near it, by small fibres or roots which are produced at every joint, which fasten to the bark of the tree, and by which the plants are often nourished when they are cut or broken off from the root, a considerable height from the ground, in like manner as the ivy is often seen in England. The leaves are as large as those of the common laurel, but are not quite so thick. These are produced alternately at every joint, which are 6 or 7 inches asunder, and are of a lively green colour on the upper side, but of a paler green underneath. The stems of these plants shoot into many branches, which fasten themselves also to the branches of the trees, by which means they rise 18 or 20 feet high, and spread quite over some of the smaller trees to which they are joined. The flowers are of a greenish yellow colour, mixed with white, which, when fallen, are succeeded by the fruit, which are 6 or 7 inches long. The method used to prepare the fruit, is, when it turns of a yellow colour, and begins to open, to gather it, and lay it in small heaps to ferment two or three days, in the same manner as is practised for the cocoa or chocolate pods; then they spread them in the sun to dry, and when they are about half dried, they flat them with their hands, and afterwards rub them over with the oil of palma christi, or of the cocoa; then they expose them to the sun again to dry, and afterward they rub them over with oil a second time; then they put them in small bundles, covering them with the leaves of the Indian reed, to preserve them. These plants produce but one crop of fruit in a year, which is commonly ripe in May, fit for gathering; for they do not let them remain on the plants to be perfectly mature, because then they are not so fit for use. While the fruit is green, it affords no remarkable scent; but as it ripens, it emits a most grateful aromatic odour. When the fruit begins to open, the birds attack them and devour all the seeds very greedily, but do not eat any other part of the fruit. The fruit which are brought to Europe, are of a dark brown colour, about 6 inches long, and scarce an inch broad; they are wrinkled on the outside, and full of a vast number of black seeds, like grains of sands, of a pleasant smell, like balsam of Peru." The best kind to experiment with in British gardens is *V. planifolia*,—a climber introduced from the West Indies in 1800; and any attempt to bring it to fruit must be aided by artificial fecundation; and this is done by carefully removing the retinaculum which covers the stigmatic part of the column, and then drawing out the inward-turned anther and pushing it down till it comes in contact with the bearded stigmatic part. By this management fruit have recently been obtained in British hothouses as finely fragrant as any which are imported from Mexico.

VAPOUR. A body in such an aeriform state as, while for the time truly gaseous, has a readiness to return to the liquid or the solid state at or above ordinary temperature and pressure. See the article Aeriform Bodies. Vaporization, or the conversion of a liquid or a solid into vapour, is effected by heat; and takes place either slowly and quietly in evaporation, or rapidly and tumultuously in ebullition. See the articles Evaporation and Boiling. A considerable number of substances will not vaporize under the strongest heat of our furnaces; a few, such as arsenic, camphor, and sal-ammoniac, pass direct from the solid state into vapour; and the great majority are first liquefied and then vaporized, and differ very widely from one another as to the degree of heat by which their vaporization is effected, and as to the comparative density

which their vapours assume. The vapour of water is lighter than air, at the same temperature and under the same pressure, in the proportion of 1,000 to 1,604; but the vapour of alcohol is half as heavy again as air, and that of ether is more than twice and a half as heavy. See the article GAS. The determination of the height of the plane of watery vapour in the atmosphere, is a desideratum of great meteorological importance, and connects itself with all the most interesting questions regarding the distribution of aeriform water over the globe, and regarding the irrigation of the continents. But one of the best and most recent attempts toward it, made in a series of experiments during Sir James Ross's voyage of discovery to the Southern Seas, was in a great measure a failure, and attained no more than a vague approximation, "giving an elevation of about 2,000 feet as its mean height in the tropical regions." See the article ATMOSPHERE.

VARIETIES IN PLANTS. The tendency is more or less common in all plants, to vary from the character first stamped upon them. This disposition is increased by removal from their native climate or locality, and greatly by cultivation. By a constant selection of some particular quality in successive crops, a gradual removal from the character of the original is effected. Most of our finest fruits, we have reason to believe, have been gradually produced by the improvement of the original native kinds. The improvements effected in former ages, were doubtless the result of accident, as the ancients were ignorant of the means for their systematic accomplishment. The greatest progress in the art which has been made in modern times, was effected by Van Mons in Belgium, and by Knight in England.

The former, who directed his labours chiefly to the pear, produced many new and excellent varieties, by a constant and successive selection of the best seedlings. He first made a large collection of natural stocks, choosing those which, from the appearance of the wood and leaf, he had reason to believe, would be most likely to produce the best fruit. As soon as the first of these bore, he selected the best, and planted the seeds. Selections were again made from the first fruit of these, and so on in continued succession, the best and soonest in bearing were uniformly chosen. He thus obtained fruit from the eighth generation; each successive experiment yielding an improved result on the preceding. At the fourth generation many of the fruits were good, several excellent, but a smaller number still bad. He had, in the early part of this series of experiments, no less than eighty thousand trees; hence in selecting from so large a number, his chance for fine ones was vastly greater than from a small collection; and hence too the reason why, after seven or eight improving generations, he had obtained so many hundred fine sorts. In the early stages of his operations, he found "that twelve or fifteen years was the mean term of time, from the moment of planting the first seed of an ancient variety of the domestic pear, to the first fructification of the trees which sprung from them. The trees from the second sowing, yielded their first fruit at an age of from ten to twelve years; those of the third generation, at an age of from eight to ten years; those of the fourth generation, at an age of from six to eight; and those of the fifth generation at the age of six years. Van Mons, being actually at the eighth generation, has informed me," says Poiteau, "that he has obtained several pear trees which fruited at the age of four years." When his seedlings were at the age of three or four years, he was able to judge of their appearances, though they had not as yet borne; such only were taken for further trial, as exhibited the strongest probability of excellence. It is hardly necessary to remark that in all these trials, the young trees were kept in the highest state of cultivation. Van Mons maintained that, by planting the seeds of the first crop, the product would be less liable to run back to the original variety, than where the seeds were taken from a crop produced on an old bearing tree; and to this practice he chiefly ascribed his success.

The production of new varieties is greatly facilitated by cross-impregnation, or by intermixing the pollen and stigma of two varieties, for the purpose of procuring something of an intermediate nature. This was performed with great success by Knight. Selecting two varieties for operation, while yet early in flower, and before the anthers had burst and discharged the pollen, he cut out with a fine pair of scissors all the stamens, leaving the stigma untouched. When the stigma became mature, he introduced the pollen (the fine dust of the bursting anthers) of the other variety, either by shaking the flower of the latter, deprived of its petals, over the stigma, or by transferring it on the point of a camel's-hair pencil, from one flower to the other. The seeds of the fruit, thus yielded, partake of the nature of both; and the trees growing from them, bear fruit of various intermediate mixtures.—*Thomas's Fruit-Culturist.*—See the article HYBRIDIZING OF PLANTS.

VARRONIA. A genus of ornamental, exotic, ligneous plants, of the cordia family. About a dozen species, all white-flowered evergreens, varying in natural height from 4 to 30 feet, have been introduced to British collections, principally from tropical America; and about 20 more are known. All the introduced species are propagable from cuttings; most love a soil of sandy loam; and one, the alder-leaved, ranks in its native country as a fruit-tree.

VASCOA. A small genus of ornamental, Cape-of-Good-Hope, yellow-flowered, evergreen shrubs, of the genista division of the leguminous order.

Two species, the perfoliate and the stem-clasping, both about 4 feet high and blooming in July and August, have been introduced to British gardens; and they love a soil of peaty loam, and are propagated from cuttings. The name vascoa was given in honour of the celebrated navigator Vasco de Gama.

VASCULARES. One of the two grand or primary divisions of the vegetable kingdom. It is very nearly identical with the Phænogamia of Linnæus and the Cotyledoneæ of Jussieu; but is preferred to these by later botanists on account of its expressing a more important and more extensively constitutional character. The same plants, when viewed as phænogamous, have true or obvious flowers,—when viewed as cotyledonous, have true or lobed seeds,—and when viewed as vascular, have not only cellular tissue, but a system of tubular and spiral vessels. Though the characters of flower and seed are sufficiently distinct for every purpose of mere classification, yet they exist only in very small parts of a plant, and in parts not present during the greater portion of the year, and are in some instances far too obscure and minute to serve as indications to a merely popular observer; but the character of vascularity pervades the whole structure, and remains patent to observation at all seasons of the year and in all conditions of the plant; and developes broad exterior distinctions which are readily recognised by the most unpractised eye. Many vascular plants, in particular, declare themselves to every peasant by the existence of woody fibre; and both these and all the others proclaim themselves in the veinedness of their leaves. See the articles CELLULARES and BOTANY.

One set of vessels in vascular plants are simple tubes called lymphatics by Decandolle, false tracheæ by Mirbel, and corpus culiferous or globule-bearing tubes by Dutrochet. They have no valves and no lateral intercommunication; they abound in both the hard wood and the soft wood of ligneous exogens, particularly between the concentric layers of different years, but do not occur in either the pith or the bark; they are studded with small globules or molecules, which lie embedded in their walls; and they serve as the channels of the ascending sap, and may readily be seen to pour out from the orifices of their section the bleeding juice of a cut vine.—Another set of vessels are short, oblong, spindle-shaped tubes, swollen in the middle, pointed at the extremities, and often divided by transverse plates. They consist of very firm membrane, but have no globules; they are arranged in longitudinal series along the alburnum and the bark, down to the interior of the root; those of adjoining series touch one another at the middle, but have spaces for other vessels between their intrinsically contracting and mutually receding extremities; and all have lateral communications and a porous wall, and serve to conduct the cambium or elaborated juice from the leaves of all the plant's exterior downward and retrogradingly through all its spray and branches and stem and root.—A third set of vessels are spiral tubes or tracheæ,—fine, filmy, and transparent, twisted in the form of a corkscrew, either from right to left, or from left to right,—occasionally interspersed with the other sets of vessels, but easily distinguishable from them by their spiral form and their filminess,—terminating each in a sort of conical and spiry point,—and furnished with nervous globules similar to those of the cells. The functions and even the structure of these vessels have been a subject of great debate and of wide diversity of opinion among phytologists; and we shall therefore, in the following paragraph, quote a somewhat extended account of them from Keith.—A fourth set of vessels are tubes of similar form and character to the lymphatics, but comparatively very wide in diameter, destitute of globules, and serving to convey the descending and secreted fluids peculiar to each species of plant, such as the yellow juice of the celandine and the milky secretion of the spurges, and therefore called proper vessels. They occur in both ligneous and herbaceous plants; and occupy comparatively large space in some of the most succulent and lactiferous and mucilaginous species.—A fifth set of vessels are articulated cellular tubes, or series of cells so concatenated as to be aggregately tubular, furnished with globules and free from pores,—some of them radiating from the centre of the stem to the circumference of the alburnum, and constituting what are popularly termed the medullary rays of trees and shrubs,—and others extending longitudinally through the plant, within the bark, at right angles to the radiating ones. The office of these vessels is fully more obscure than even that of the spiral vessels; and probably is dependent on the office of the pith; and possibly also has connexion with the function of a supposed sixth set of vessels, of very filmy texture, of anastomising power, and of retiform distribution through all parts of the plant, from the root to the leaves and from the centre to the circumference,—a set of vessels, however, whose very existence, to say nothing of their offices, is yet matter for enquiry.

"Grew and Malpighi, who first discovered and described the spiral vessels," says Keith, "represented them as resembling in their appearance the tracheæ of insects, and designated them by that name,—an appellation by which they are still very generally known. They do not occur often in the root, or, at least, they are not easily detected in it, though Kieser is said to have found them in it, in great abundance. Dutrochet could find none, and denies their existence in the root expressly. For myself, I can safely affirm that I have repeatedly met with them in the root of the lettuce called cos lettuce, though not in any other root that I have ever

examined in search of them. Neither are they to be found in the branch or stem of woody plants, except in the annual shoot; nor in the pith of any plant, except in the several species of nepenthes. But in the stem and branches of herbaceous plants, they are generally to be found without much difficulty, accompanying the longitudinal fibres, and forming part of the bundles. They are very easily detected in the foot-stalk, whether of the leaf or flower. They are discoverable also in the leaf itself; though rarely in the calyx and corolla; and more rarely still in the other parts of the flower. Grew and Malpighi found them both in fruits and seeds. I have myself met with them in the external umbilical cord of the seed of the cherry, at a very early period of its growth,—that is, about the time of the falling of its petals,—but not in any other fruits. In the leaf or leaf-stalk of the artichoke, the spirals are not only remarkably large, but also remarkably beautiful, exhibiting the appearance of spiral coats investing interior fibres, rather than that of a distinct and individual tube, and seeming, when uncoiled, to be themselves formed of a net-like film, consisting of three principal and longitudinal stripes. At present, we find that the botanical adepts are divided on this subject, one party contending that the spires are external to the tubes as they appeared in the case just stated; and the other party contending that the spires are, on the contrary, internal, forming a lining to the tubes, and not a coating. Dr. Brown espouses the former opinion, and Professor Henslow espouses the latter. Is it certain that the organs now under consideration are tubes? In the closely coiled up state in which they exist in the growing plant, they might be said to constitute tubes by the union of their spires. Divide a leaf-stalk of the artichoke or of the elder longitudinally, cutting it partly, and tearing it partly asunder, and place a portion of it under the microscope. Inspect the exposed surface of it carefully and in a strong light, and it will present to your view bundles of spirals in their coiled up and united state. Divide a portion of the same leaf-stalk transversely, cutting it partly, and breaking it partly asunder. Place it under the microscope in a clear and strong light, and multitudes of spirals, not yet divided, but merely drawn out, and partly uncoiled, will be found to connect the fractured surfaces; and if you stretch them even till they give way, the fragments will, as if by an elastic and inherent spring, coil themselves up again, nearly as before; yet the prevailing opinion seems to be that the spire does not in any case constitute a tube, but forms merely a coating or lining to a tube within it or without it. —Much has been said with regard to their functions. Malpighi regarded them as destined to the transmission of air. Grew thought they transmitted, not only air, but sap. Mirbel regards them as being well fitted for the transmission of the ascending sap. Mr. Knight thinks they are altogether incapable of transmitting moisture. Yet Hedwig and Senebier concurred in affirming that a fluid may be seen issuing from their orifices, if the horizontal section of a stem is inspected immediately after its division. Hence they are doubtless capable of conducting a fluid, whether it be the ascending sap or not. The latest hypothesis with regard to their function is that of M. Dutrochet. He shows that they cannot be the channel of the sap's ascent, because they do not exist either in the root or stem, except as aforesaid,—that is, in the annual shoot. He shows also that they contain a fluid *sui generis*,—that is, a diaphanous fluid, which is neither air nor sap. He infers that their function is in accordance with that of the leaves, because it is in the leaves that they occur in the greatest abundance. But leaves are vegetable lungs, and as animals receive a vivifying influence from oxygen in the lungs, so plants, through means of the leaves, receive a vivifying influence from the light of the sun, either directly or in combination with the fluids they contain; which influence the spirals or tracheæ convey to the interior, and are hence to be regarded as organs of insolation."

VASCULAR ORGANS. See VASCULARES.

VAT. A large vessel for holding any fermented alcoholic liquor, such as wine, ale, beer, cyder, or perry, during the process of its preparation.

VATERIA. See TALLOW (PINEY.)

VAUANTHES. An ornamental, Cape-of-Good-Hope, yellow-flowered, annual plant, of the crassulaceous order. It was called by Linnæus *Crassula dichotoma;* but it now constitutes a genus of itself, with the specific name of *chloræflora*. It has a height of about 6 inches; and is only half-hardy.

VEAL. The meat or well-fed carcase of a calf. See the articles CALF and MEAT. The fillet of a cow-calf, under any ordinary conditions of breed and age and feeding and aggregate fitness for the market, is less firm in the groin and more curdled in the fat than that of a bull-calf; and is therefore generally preferred to it. If a shoulder of veal have not a bright red colour in the vein, it is stale; and if it have any green or yellow spots, it is totally unfit for use. The neck and breast, if white and dry, are good; but, if clammy, and greenish or yellowish at the upper end, they are bad. The loin generally taints first under the kidney; and whenever it becomes soft and slimy, it is stale. If the leg be white and firm, it is good; but if it be flabby, and show any greenish or yellowish specks, it is bad.

VEGETABLE. A plant. See the articles PLANT and VEGETABLE PHYSIOLOGY.

But the word vegetables, in the plural number, is popularly used as the proper aggregate designation of culinary plants, or of such as are cultivated in the kitchen garden. The chief of

these in Britain are the following:—Cabbage plants, whose leaves or unexpanded flowers are pickled or made into sauerkraut or eaten boiled,—white cabbage, red cabbage, savoy, borecole, Brussels sprouts, cauliflower, and brocoli. Spinaceous or oleraceous plants, whose leaves are eaten boiled,—spinach, New Zealand spinach, white beet, sea-beet, turnip-tops, orach or mountain spinach, good king Henry or wild spinach, white orach or fat-hen, sorrel, French sorrel, stinging-nettle, herb patience or patience-dock, spotted hawkweed, pilewort, sowthistle, sauce alone or Jack by the hedge, black bryony, and chickweed. Acetaceous or salad plants, whose leaves or whole herbaceous parts are eaten raw as salad, along with vinegar and spice,—lettuce, endive, succory, or wild endive, ox-tongue, dandelion, ox-eye daisy, milk-thistle, yarrow or milfoil, white cabbage, radish, charlock, mustard, rape, garden rocket, water cress, garden cress or wild rocket, French or American cress, yellow rocket or winter-cress, scurvy-grass, ladies-smock, corn-salad or lamb-lettuce, brooklime, burnet, sorrel, garden sorrel, French sorrel, alpine sorrel, wood sorrel, nasturtium or Indian cress, purslane, sea bindweed, sweet cicely, chervil, celeriac, celery, angelica, borage, spearmint, cowslip, primrose, and plantain or star of the earth. Pot or garnishing herbs, whose roots, leaves, or flowers are used to flavour soups and garnish dishes,—horse-radish, parsley, purslane, tarragon, fennel, dill, chervil, sweet cicely, anise, Indian cress or nasturtium, marigold, sea-flower, crocus or saffron, and borage. Alliaceous plants, whose bulbs are used either boiled, raw, or pickled,—onion tree or bulb-bearing onion, rocambole, Welsh onion, chives, leeks, garlick, and shalot. Sweet or aromatic herbs, whose young sprigs are used generally to flavour stuffings or soups,—thyme, lemon-thyme, sage, clary, spearmint, peppermint, pennyroyal, pot marjoram, sweet marjoram, winter marjoram, common marjoram, summer savory, winter savory, sweet basil, dwarf or brush basil, rosemary, lavender, tansy, and balm. Asparagaceous plants, whose young shoots, peeled leaf-stalks, flower-scales, or fruit-flesh are eaten boiled on toast with butter, or are occasionally made into pies,—asparagus, good king Henry, bladder-campion, hop, Alexanders, Persian willow or willow-herb, cardoon, rhubarb, burdock, thistle, celery, sea-kale, artichoke, milk-thistle, cotton-thistle, pompion, water-melon, squash, and vegetable marrow. Esculent-rooted plants, whose roots are mostly eaten boiled, or rarely raw when young, and sometimes made into bread,—potatoes, Jerusalem artichokes, turnips, turnip-rooted cabbage, radish, rampion, beet, parsnip, carrot, skirret, Hamburgh parsley, scorzonera, salsafy, arrowhead, bitter vetch, earth-nut, meadow-sweet, salep, silver-weed, Solomon's-seal, and black bryony. Leguminous plants, whose fruit is eaten boiled, either enclosed in the pod when tender, or shelled, or whose seeds are ground when ripe,—pea, sea-pea, bean, dwarf and running kidney-beans. Pickling plants, whose whole substance, or whose bulbs, leaves, flowers, or fruit are used in pickling,—onions, samphire, marsh-samphire, sea-convolvulus, sea-sandwort, sea-orach, sea-salsola, golden samphire, red cabbage, capers, marsh-marigolds, cauliflower, love-apples, egg-plants, cucumbers, capsicums, cherry-pepper, bell-pepper, and Indian cress or nasturtiums. Edible algæ, or sea-weeds,—sweet fucus or sea-belts, dulse, red dulse, bladder-leeks, ciliated dulse, fringed dulse, pepper dulse, bladder or hunting fucus or gulf-weed, oyster-green, and lava. Edible fungi, — cultivated mushroom, champignon, chanterell, morrel, and truffle. Medical plants, whose whole substance, or whose leaves, flowers, or fruit are used in domestic medicine, — angelica, anise, coriander, carraway, parsley, dill, fennel, agrimony, marsh-mallow, rue, hyssop, balm, sage, arum, assarabacca, ladies'-smock, chamomile, lesser centaury, meadow-saffron, elecampane, liquorice, carrots, wormwood, southernwood, Roman wormwood, scurvy-grass, leeks, garlic, sea-holly, and dandelion. Confectionary plants, which are used in tarts, puddings, or candying,—angelica, celery, elecampane, rhubarb, vegetable marrow, pompion, carraway, coriander, and anise.

Kitchen vegetables, particularly such bulky and common kinds as the succulent roots and the brassicas, form an essential part of the sound and healthy food of human beings,—insomuch that any person who long and entirely wants them is certain to suffer serious derangement of his constitution, or to contract some severe disease; and when used largely and judiciously, with a due regard to the tone of the stomach, and with a proper selection of the most saline and succulent kinds, they act as a prompt remedy for scorbutic complaints and for various kinds of general debility. Any method, therefore, for preserving them long in a fresh state, in voyages at sea, or in other situations where frequent supplies of them cannot be obtained, is of vast importance for the conservation of health. About 10 or 12 years ago, a new and curious method of preserving them was discovered by M. Braconnot, and is said to have proved highly efficient, after being tested by a number of trials. This method is as follows:—Provide a cask furnished with an opening, which fill three-quarters with the vegetables which it is desired to preserve. At the opening, fix an iron wire, to which suspend a match of sulphur, which set on fire. After burning for some time, shake the cask, and put on the vegetables sheets of paper which have absorbed sulphuric acid for a time. Fumigate the cask with burning brimstone at two different times, taking care to preserve the vegetables and sheets of paper from the embers of the match when burning. The vegetables, after parting with the water of vegetation, appear boiled. After this process they are put into stoneware

pots and placed in a cellar, without any other precaution than a covering of parchment. When you wish to use the vegetables, all that is necessary is to let them steep some hours in water, their cooking taking no more time than that given to vegetables recently gathered, and their taste is as agreeable. M. Braconnot extended his trials to many sorts of vegetables, among others to sorrel, Roman lettuce, common lettuce, and asparagus; and they all afforded him satisfactory results. He found, however, that the sulphuric acid was usefully employed only when applied to tender vegetable substances, susceptible of prompt cookery.

VEGETABLE ACIDS. Compounds which possess the properties of an acid, and are derived from the vegetable kingdom. A brief account of them has already been given in the article Acids. They are, for the most part, less liable to spontaneous decomposition than other vegetable principles; and they probably owe their comparative stability to the large proportion of oxygen which they contain. They constitute a highly important class of organic substances; and are nearly four times as numerous as the vegetable alkalies; and differ very widely from one another in transformative power and aggregate chemical behaviour; and, in many instances, play a conspicuous part both in the organic chemistry of nature and in the economical chemistry of art. About one half consist, in various proportions, of oxygen, carbon, and hydrogen; two, the oxalic and the croconic, consist only of oxygen and carbon; two, the indigotic and the carbazotic, consist of oxygen, carbon, and nitrogen; five or six consist of oxygen, carbon, hydrogen, and nitrogen; and the rest either have not been carefully analysed, or consist of some other powerful acid, such as the sulphuric, in combination with alcohol, with ether, or with some other vegetable principle. One class, comprising between one-sixth and one-seventh of the whole, are volatile acids, or may be volatilized without decomposition; and the most interesting of these are the acetic, the lactic, the oxalic, the sebacic, the formic, the benzoic, and the hippuric. A second class, comprising about double the number of the preceding, are fixed acids, which cannot be volatilized or distilled over without decomposition, and which, when exposed to a sufficient degree of heat, are resolved into other acids called pyracids; and the most interesting of these are the malic, the citric, the racemic, the gallic, the meconic, the tannic, the ulmic, and the caffeic. A third class, comprising a rather greater number than the first, are oily acids which result from the boiling of wax or fixed oils with potash or soda, and whose combination with the alkali constitutes soap; and the most interesting of these are the margaric, the stearic, and the ænanthic. A fourth class, about half as numerous as the first, are azotic, or have nitrogen in their composition, and in consequence possess a nearer kindred than the rest to the proximate principles which distinguish the animal kingdom; and the most interesting of these are the carbazotic, the azulmic, and the cholesteric. A fifth class, nearly equal in number to the first, are imperfectly examined acids, whose constitution is obscurely known or is matter of dispute; and the most interesting of these are the pectic, the crenic, the apocrenic, and the gummic. And a sixth class, nearly half as numerous again as the first, are compound acids, which consist of a vegetable principle in combination with a strong mineral or vegetable acid; and the most interesting of these are the xanthic, the tartrovinic, the sulphocetic, stearin, and olein.

VEGETABLE ALKALIES. See Alkaloids.

VEGETABLE CHEMISTRY. Either the chemistry of vegetation, whether with reference to the actions which take place in the interior of plants, or with reference to the agencies which affect and control and determine them from without; or the chemistry of vegetable principles,—both those which are formed by living plants, and afterwards separated from them by artificial processes, and those which result from the excretion or death or decay of plants, or which are artificially formed out of portions of their substance by manipulation or chemical reaction. In the former sense, vegetable chemistry, in its various parts and phases, is very abundantly treated in the articles Organic Chemistry, Agricultural Chemistry, Manure, Food of Plants, Farm-Yard Manure, Salts, Alkalies, Air, Electricity, Ammonia, Azote, Carbonic Acid, and many others; and in the latter sense, it is treated with sufficient fulness and frequency for all the purposes of the various classes of our readers, both in articles on entire classes of vegetable substances, such as Alkaloids, Vegetable Acids, Oils, Resins, Gums, Salts, and Balsams, and in articles on each of the most important principles which are used either in medicine, in domestic economy, or in the arts, such as Sugar, Starch, Alcohol, Protein, and all the chief oils, gums, resins, and salts, and all the chief artificial products of destructive distillation and artificial recombination. "The chemistry of vegetable principles," says Dr. Thomson, "has made considerably greater progress than that of animal principles; chiefly because the former have a greater tendency to crystallize, and, in consequence of this property, can be more easily obtained in a state of purity than the latter. This is the case with most of the vegetable acids and alkaloids, with sugar and some other substances not easily classified. Others are volatile, and are formed or driven off at particular temperatures. Alcohol, ethers, and volatile oils are in this predicament. Pretty frequently several of these volatile bodies occur together; and in such cases we have scarcely the means of obtaining them in a state of purity, unless when they enter into definite and crystallizable com-

pounds with some other substance. It is not unlikely that all the vegetable principles may be found hereafter to be capable of entering into definite compounds with other bodies, and that they will be ultimately possessed of the character of acids or bases. But there are a good many vegetable principles which, so far as our present knowledge extends, do not seem capable of forming any such definite compounds. Thus caoutchouc neither combines with acids nor bases. We must consider such bodies as neutral. There exist also several groups of bodies which have been distinguished by a common name, some of which neutralize acids, and therefore ought to constitute bases, while others belonging to the same group neutralize bases, and therefore ought to constitute acids; while a considerable number of the bodies belonging to the group has been so imperfectly examined, that we do not know whether they be acids or alkalies. This is the case with the group of bodies distinguished by the name of volatile oils. Oil of turpentine saturates muriatic acid, and therefore is a base; while oil of cloves saturates bases, and therefore is an acid. But many of the other volatile oils have been so imperfectly examined, that we could not venture to place them either among bases or acids." "Nearly all bodies of vegetable origin," says Dr. Turner, "are composed of oxygen, hydrogen, and carbon; and in a few of them, nitrogen is likewise present. Every distinct compound which exists ready formed in plants, is called a proximate or immediate principle of vegetables. Thus sugar, starch, and gum, are proximate principles. Opium, though obtained from a plant, is not a proximate principle; but consists of several proximate principles mixed more or less intimately with each other. The proximate principles of vegetables are sometimes distributed over the whole plant, while at others they are confined to a particular part. The methods by which they are procured are very variable. Thus gum exudes spontaneously, and the saccharine juice of the maple-tree is obtained by incisions made in the bark. In some cases a particular principle is mixed with such a variety of others, that a distinct process is required for its separation. Of such processes consists the proximate analysis of vegetables. Sometimes a substance is separated by mechanical means, as in the preparation of starch. On other occasions advantage is taken of the volatility of a compound, or of its solubility in some particular menstruum. Whatever method is employed, it should be of such a nature as to occasion no change in the composition of the body to be prepared. The reduction of the proximate principles into their simplest parts, constitutes their ultimate analysis. By this means chemists ascertain the quantity of oxygen, carbon, and hydrogen present in any compound." See the articles PROXIMATE PRINCIPLE, ANALYSIS, and VEGETABLE PHYSIOLOGY. The methods of analysis introduced not many years ago by Liebig and Dumas opened a new era in vegetable chemistry, and suddenly let in upon it an inundation of new facts and explanations; insomuch that several hundred new vegetable substances were discovered in a very brief time by these two distinguished chemists and their pupils, and many of the most talented young chemists both on the Continent and in Britain were induced to devote their main strength to enquiries in that direction, and such multitudes of accessions began to be made to the knowledge of chemical reactions and combinations within the vegetable kingdom as speedily raised the study of organic chemistry to as broad a platform of investigation and to as lofty an influence over economics and the arts as that of all the combined departments of the general chemistry which had been accumulating its resources for centuries. Agricultural chemistry, therefore, which is but one department of vegetable chemistry, has already become a separate and great science.

VEGETABLE EXCRETION. See EXCRETION OF PLANTS.

VEGETABLE EXTRACT. See EXTRACT.

VEGETABLE JELLY. See PECTIN.

VEGETABLE LIFE. See ORGANIC CHEMISTRY.

VEGETABLE MARROW. The succada gourd, —a variety of the egg-bearing gourd, *Cucurbita ovifera*. It is an annual; and is raised under a hand-glass or in a frame, and afterwards transplanted into a warm aspect, and trained to a trellis or to some similar support. Its fruit is uniformly of a pale yellow colour, and of an elliptic-oblong shape; and when full grown, is about 9 inches in length and 4 inches in diameter. It is by far the best of the gourds for culinary purposes; and, though generally eaten when about the size of a hen's egg, may be used at any stage of its growth. When very young, it does well to be fried with butter; and when half-grown, it is excellent either plain boiled or stewed with rich beef-gravy; and, in either case, it requires to be cut into slices. It takes its name of vegetable marrow from the peculiar tenderness and softness of its flesh.

VEGETABLE MORPHOLOGY. See MORPHOLOGY.

VEGETABLE MOULD. See HUMUS.

VEGETABLE PHYSIOLOGY. The science which treats of the structure, functions, and vital phenomena of plants. It either may be understood quite comprehensively as discussing all matters which concern living plants, in the same wide way in which zoology discusses all matters which concern living animals, and it then may be more properly called phytology; or it may be taken more limitedly as discussing only matters which concern the organisms and the organic operations of living plants, irrespective of specific habits and chemical constituencies and external connexions, in the same limited way in which animal physiology treats only of

the organisms and organic functions of living animals, and it then may be more strictly designated vegetable physiology. Yet the two definitions so run into each other as to be of little or no use for any purpose of either practice or theory; and we therefore may follow them indifferently—now the one and now the other—in all that we have to say.

The philosophers of ancient Greece and Rome had no notions of vegetable physiology which are worth recording; and even the philosophers of modern Europe down to the time of Bacon continued unacquainted with both the anatomy of plants and all the true principles of vegetation. Dr. Hooke, who published in 1667, and who examined wood-charcoal and saw the small cells and the opening of the spiral vessels, was the first person who applied a microscope to the examination of the structure of plants; and Dr. Grew, an English physician, and Malpighi, an Italian anatomist, both of whom published in 1671, were the first observers who conducted such searching and extensive investigations by dissection and microscopical examination as either to lay a true foundation for phytological science, or to amass any considerable materials for rearing its superstructure. "They had no mutual intercourse, and yet their experiments and observations are so nearly alike that the one might seem copied from the other. The characteristics of both are minute and accurate observation, careful experiment, and cautious deduction from a large collection of instances. Hence we find that no organ of the plant escapes their inspection; roots, trunks, branches, leaves, flowers, fruits with their appendages, are all subjected to the most rigid and minute scrutiny, as well as those parts and organs which are discoverable only by the dissection or anatomy of the plant,—the pith, the wood, the bark, the epidermis, together with the fibres, tubes, or membranes into which they are further separable. This enquiry is followed by a careful enquiry into the respective uses of each, in the economy of vegetation,—which is ascertained by watching with the most unwearied assiduity the phenomena of vegetable life,—the functions of the several organs of the plant,—the 'latens processus naturæ, in casu ubi fit inquisitio ex quibus initiis, et quo modo et quo processu herbæ generuntur, a primis concretionibus succorum in terra, a seminibus, usque ad plantam formatam, cum universa illa successione motus, et diversis et continuatis naturæ nixibus.'" Many distinguished philosophers, from the latter part of the 17th century down to the present age, particularly Ray, Camerarius, Geoffrey, Vaillant, Linnæus, Hales, Bonnet, Duhamel, De la Baisse, Cotta, Van Marum, Mustel, Hedwig, Spallanzani, Sprengel, Treviranus, Link, Rudolphi, Mirbel, Knight, Kieser, Dutrochet, Amici, Brongniart, and Brown, followed in the footsteps of Grew and Malpighi and in those of one another, each contributing new materials to phytological science, or correcting the observations of predecessors, till the whole structure and organic economy of a plant, and even of every part of it, have become almost as completely known as those of the highest orders of vertebrated animals, and till either clear notions or luminous and consistent theories have been obtained upon such topics as the processes of nutrition and assimilation, the offices of the spongioles and the stomata, the use of the several kinds of cells and vessels, the structure and development of seeds, the descent of the radicle and the ascent of the plumule, the peculiarities of root and stem and leaves, the several nature of bark and wood and pith, the differences of secretion and excretion, the ascent of the sap and descent of the cambium, the elaboration of liquid from the root with gases from the leaves, the origin of buds and branches, the irritability and vital economics of the general system, and even the obscure and mysterious process of vegetable fecundation.

The early phytologists alluded chiefly to organic phenomena, and but slightly to functional, and not at all to chemical or to vito-chemical. "The first experimenters," says Keith, "seem to have had in view nothing beyond the mere analysis of their constituent parts, or rather of their medical properties,—which they endeavoured to ascertain by means of the processes of infusion, decoction, evaporation, distillation, and combustion, torturing the vegetable subject in every possible way and making much use of the crucible. It cannot be said that their researches were altogether unprofitable; but certainly they did nothing to elucidate the phenomena of vegetation. The key to that mystery may be said to have been first found by Priestley, when about the year 1771 he discovered the extrication of oxygen gas, by the leaves of plants, when exposed under the water to the rays of the sun. The path thus opened up was afterwards successfully explored by Ingenhouz and Senebier, who extended their researches to a variety of other phenomena; and from that time chemical phytology has continued to attract the notice of almost all chemists of distinction; among whom we may particularly mention Lavoisier, Fourcroy, Vauquelin, Gay Lussac, and Thenard, in France,—and in this country, Chenevix, Thomson, Ellis, and Davy. But the individual who, after Priestley, has perhaps the strongest claim to originality in these investigations, is Saussure the younger, who, in the true spirit of the Baconian philosophy, has watched and investigated, not merely the phenomena of vegetable life, but even the phenomena of vegetable death and decomposition, demonstrating the peculiar and indispensable agency of oxygen in the germination of the seed,—the absorption of moisture by the root,—its elaboration in the leaf, by the alternate inhalation and extrication of oxygen and of carbonic acid gas, by night and by day,—the de-

composition of water,—the descent of the cambium and its conversion into wood and bark;—and, lastly, the primary principles of which plants consist, or to which they may be reduced, —carbon, oxygen, hydrogen, azote."

We have discussed the structure of plants in the articles Botany, Acotyledonous Plants, Cellulares, Compositæ, Cruciferous Plants, Cryptogamous Plants, Dicotyledonous Plants, Endogens, Exogens, Leguminous Plants, Monocotyledonous Plants, Organization, and a great many others; the parts, members, and organs of plants, in the articles Air-Vessels, Anther, Aril, Armature, Bark, Berry, Bract, Branch, Bud, Bulb, Calyx, Capsule, Catkin, Cellular Tissue, Corolla, Cotyledon, Culm, Down, Epidermis, Flower, Frond, Fruit, Germ, Gland, Involucrum, Kernel, Leaf, Nectary, Nut, Ovary, Pericarp, Pith, Pollen, Radicle, Root, Sap, Seed, Spongioles, Spore, Stamens, Stem, Tuber, Vasculares, and many more; the constituents, secretions, and proximate principles of plants, in the articles Albumen, Alburnum, Aroma, Ashes, Balsams, Bloom, Cambium, Chlorophylle, Duramen, Extract, Fibrin, Food of Plants, Gluten, Gum, Lignin, Odour, Oil, Phosphates, Protein, Resin, Starch, Sugar, Vegetable Acids, Alkaloids, Turpentine, and a multitude of others; the general economy of plants, or their form, habit, relations, and exterior susceptibilities, in the articles Acclimatation of Plants, Age of Plants, Aerial Roots, Air-Cells, Air-Plants, Analogy, Annual Plants, Aquatic Plants, Barren Flowers, Biennial Plants, Blanching, Etiolation, Grafting, Habit, Herb, Hybridizing of Plants, Morphology, Offset, Parasites, Pollen, Rotation of Crops, Seed, Tree, and many more; the exterior chemistry of vegetation, or the controlling influences which are exerted over the life and energy of plants by external agencies and outward circumstances, in the articles Aeration, Air, Agricultural Chemistry, Altitude, Atmosphere, Carbonic Acid, Ammonia, Azote, Caloric, Climate, Food of Plants, Humus, Gypsum, Irrigation, Light, Lime, Manure, Pulverization, Soil, Sowing, Temperature, Water, and many others; the organic functions and vital actions of plants, in the articles Absorption in Plants, Æstivation, Ascent of Sap, Cambium, Endosmose, Elaboration, Excitability of Plants, Excretion of Plants, Feundation, Germination, Growth, Irritability,-Morphology, Nutrition, Organic Chemistry, Secretion, Vasculares, and many more; and the diseases of plants in the articles Aphis, Blight, Canker, Ear-Cockle, Decay, Dropsy, Ergot, Extravasation, Fascia, Gall, Gangrene, Honey-Dew, Knot, Mildew, Smut, and a number of others. Any further notice of these multitudes of topics, either in groups or in a connecting manner, and much more seriatim, would be useless repetition; and, in the sequel of the present article, we shall merely notice two or three prominent facts and speculations respecting vegetable physiology which happen to have been either touched but slightly or not touched at all in other parts of our work.

The peculiar organic action of root crops, in its connexion with fallowing effects and with the economy of efficient rotations, is a subject of great practical interest to farmers; and is briefly but luminously discussed in the following terms by Messrs. Way and Ogston:—"Root crops are means, when judiciously employed, of increasing the fertility of the land,—of rendering it, that is, capable of bearing larger crops of the more valuable produce, wheat and the other cereals, which form the great staple of food for man. Now, how do they effect this? Whence the efficacy of the turnip and the mangold wurzel. What peculiar properties do these roots possess, that their cultivation should form so important a feature in modern agriculture? They are most powerful, most industrious agents in the collection and preparation of food, both mineral and vegetable, for the use of other crops. They are continually employed in abstracting by their leaves from the air the constituents of which their own vegetable substance is made up; they never cease to collect by their roots, and to bring to the surface, the mineral matters which are essential to their own growth and to that of the crops which follow them; and both these forms of matter, the organic or vegetable, and the inorganic or mineral, are (when the crop has been consumed by sheep) in great part left in the soil in the condition most favourable for the purposes of the succeeding plants. It is chiefly, however, to the accumulation of vegetable matter, that we are to attribute the influence of the root crop generally in improving the soil; for although the turnip does certainly add to the available stock of mineral ingredients of the surface soil, its own growth is very mainly dependent upon the sufficiency of their supply; and to obtain a very liberal return, we must be proportionately liberal in our grants of the materials which are indispensable to the construction of the crop. Root crops, from the great development of their gas-collecting leaves, are comparatively independent of the soil for vegetable nourishment. They may in reality add to, rather than take from, the quantity of vegetable matter in the soil, even when entirely removed; for land has been found after several years' cropping with turnips, all the produce being carried off, absolutely richer in organic matter than it was at first, the plant having returned to the soil more than it had taken from it. How much more is this the case when a large portion of the organic matter, after passing through the body of the sheep, is returned in a highly comminuted state to the land. It cannot, however, be too often insisted upon, that, whilst we may fully restore by a green or root crop all the organic wealth of which the soil has been de-

prived by the grain of a crop of corn, we have no such resource for a renewal of its mineral ingredients. The phosphoric acid, the potash, and the magnesia of a plant must be obtained from the soil, and the soil alone. But even in this respect much may be done; it may be safely predicted that a time will come when, in the cultivation of land already brought into a state of high fertility, the application of artificial manures, except in rare cases, will be looked upon as an unnecessary and unjustifiable waste of money. At the present stage of agricultural practice, the only necessary loss of its mineral ingredients which the land sustains, is comprised in that portion which is sent into our large towns in the different grains and in the bones of animals, and that other small (but unfortunately often too considerable) portion which is lost by the drainage of liquid from the stables and manure heap. The purchase of bones to restore the phosphate of lime removed by the growing of sheep and the milk of the cows, should hardly perhaps be looked upon in the light of the application of artificial manures, because nothing can be more reasonable than to give back what we have taken from the soil; and the measures now in progress for rescuing the sewerage of our large towns, and an improved system in the manufacture and preservation of natural manures at the homestead, will leave but little on the credit side of the land. But allowing a certain and considerable yearly diminution of the mineral elements of fertility in land, we have yet, so to speak, an almost infinite supply of these bodies in the soil itself, provided we knew how we might economically avail ourselves of it. This (the item of *expense*) is after all, the turning point. Most soils, if sufficiently exposed by repeated stirrings and cultivation to the action of the natural agents, water and air, would yield up abundant materials for the growth of luxuriant crops of roots, and through their means of corn. We know from the constitution of the rocks from which they have been produced, that all soils containing any clay, must contain also considerable quantities of potash; and there is every reason to believe that no sandy or chalk soil is absolutely deficient in this alkali. Again, the experiments of Dr. Daubeny and Professor Fownes have led us to believe that phosphoric acid is a constituent of the chalk and limestone strata, as well as of the older rocks; and the recent investigations of Dr. R. D. Thomson and of Mr. Sullivan, go a great way to prove that this acid, so important to agriculture, is present in all the great mineral masses of the globe, whether of ancient and igneous origin, such as granite, gneiss, and all volcanic rocks, or the more modern aqueous deposits of which so large a portion of the soil of England consists. The presence of phosphoric acid in the older rocks however is the important point, because its existence (as insoluble phosphate of lime) in the sedimentary deposits formed from the debris of the first, follows almost as a natural consequence. But though it is quite possible that, from the universal prevalence of the most important mineral constituents of crops, sufficient working of the soil would enable us to dispense with the addition of any artificial manures, it may be, and is, far more economical at the present time to supply the requisite dose of mineral matter directly than to seek to furnish it from the natural resources of the soil by a costly expenditure of mechanical force. It must be observed, however, that there are other ways of bringing into play the dormant energies of the land, besides deep and subsoil ploughing and trenching. Some plants have an extraordinary capacity and disposition to seek food at great depths in the soil—not vegetable food, for there is none in such situations, generally speaking, to be had, but mineral food. For this they will send down their roots, in many cases, to many times the depth which the most enthusiastic advocate of subsoiling would hope to attain; and in their subsequent growth at the expense of so distant a source of nourishment, they effect a far more important chemical addition to the surface soil than the subsoil plough could accomplish. The perfection of a fallow crop, either root or otherwise (other circumstances of facility of cultivation, amount and feeding properties of the crop being equal), would be that which, whilst requiring for the completion of its own structure a considerable quantity of valuable mineral ingredients, should be possessed of an energy and power of obtaining them quite independent of any extraneous supply in the shape of artificial manures. In other words, a scientific review of the conditions of vegetable growth, apart from circumstances of practical detail, would indicate as the best fallow crop a plant with large spreading leaves, strong penetrating roots, and nutritive qualities in the feeding of stock, provided that at the same time its ash were in quantity and composition such as would benefit the cereals for which it is intended to prepare the food. Of this latter point there would be little fear, supposing that the plant was really superior in feeding properties; for an examination of the evidence at present existing in reference to the ash of plants, amply demonstrates that those parts of plants (such as the seeds of the cereals) which owe their high nutritive powers to the large quantity of nitrogenized bodies (gluten, albumen, &c.) they contain, are also proportionably rich—invariably so—in phosphates of lime, magnesia, and potash. Let it not be thought from the foregoing remarks, that we can take only one narrow contracted view of the relation which the culture of the root crop bears to the whole rotation, or that we seek to explain the advantages of existing practices and modern improvements, solely upon chemical principles. A practical farmer will tell us, that there are twenty

ways in which the root crops are beneficial to his land,—that they are means in his hands for altering the texture of the soil,—that they afford him opportunity of cleansing and well stirring it, &c. This is very true; but after all, it will be found that their most important function is, as before said, the collection and preparation of food for the cereals. The root crops may be called the nurses of the tender and helpless corn plants; like nurses, they themselves require food, but their organs are of a nature to render them less dependent upon the character of that food. Food is, indeed, the first consideration to plants as well as animals. Give a man plenty of wholesome nutritious food, and he will be comparatively safe from the attacks of disease, and indifferent to the inclemency of the weather. Stint him in the supplies of this first necessary, and you leave him an easy prey to both. Is it otherwise with plants? Surely not—they too must be fed; if nature does not supply them liberally enough, the care of man must make good the deficiency; but until he knows what they require, his efforts can hardly fail of being in many cases abortive, or, where successful, attended with unnecessary waste. And here we come to the point from which we started; the cereals require two kinds of manuring, mineral and vegetable—the roots require principally only one, the first of these. Supply your roots with mineral nourishment, and whilst by the increase of their produce you are enabled (so to speak) to grow a larger quantity of mutton and beef and milk, you will ensure also a more abundant return of the more valuable crops, for which the turnip and mangold wurzel eventually become the mineral as well as vegetable sustenance."

The connexion of heat with vegetable life and growth is intimate and manifest, yet involves questions of much intricacy, and is so interwoven with accompanying connexion of light, electricity, moisture, and chemical reaction as to present many and strong obstacles to searching investigation. A power is evidently possessed by the living plant of preventing the freezing of its sap amid a temperature far below that at which the inmost juices of the same plant when dead would become frozen; but what that power consists in, or through what precise means it operates, further than the theoretic certainty of its essential connexion in some way or other with life, is utterly unknown. Plants, indeed, in some ways or through some organ or in some particular stages or functions of their growth, are capable of generating very considerable quantities of heat, and sometimes evolve it in sufficient quantity to be perceptible, and may be supposed to form it by the inhalation of oxygen and the burning of carbon in a particular organ or organs in some such method as is done by animals in the organs of respiration; and though the texture of such organ or organs is so exceedingly minute as to have hitherto eluded actual observation, their existence may be satisfactorily inferred, not only from the general fact of generated heat being evolved, but from the particular one that oxygen is inhaled by petals as distinctively as carbonic acid is inhaled by leaves, and especially is absorbed in large quantity by flowers at the instant of fecundation.—Yet the temperature which mainly affects plants is not that which originates within themselves, but that which is suffused around them in the soil and in the atmosphere. A certain degree of exterior temperature is necessary to every plant for the germination of its seeds, the development of its flowers, and the maturation of its fruits; and as this very largely depends upon climate, it both controls the native adaptation of different species of plants to different zones and altitudes of the world, and powerfully modifies the phenomena of vegetation in any one species when removed from its native region to one which is either considerably colder or considerably hotter. The seeds of tropical plants, when sown in temperate climates, germinate much later than in their native regions,—and when sown in gardens, require such a considerable elevation of temperature as can be obtained only in greenhouses or on hotbeds or in stoves; and those of cold countries bordering on the frigid zones, when sown in temperate climates, germinate much earlier than in their native regions, —and when sown in gardens, require to be deposited in the coldest and most shady spots of the open ground. A difference of temperature, in any one district, in one and the same season in different years, likewise exercises a great influence on the epochs of germination, so that, not unfrequently, the seeds of the same plants germinate much earlier when the spring arrives soon, and a mild rainy winter had preceded it, but much later when the heat of spring has been delayed by a severe winter. The unfolding of the leaf buds, and the development of the flowers are also subject to the same changes which are observable in the germination of seeds. According to observations made, at the request of Schübler, by the naturalists assembled at Berlin in the autumn of 1828, during the following summer at Parma in Lombardy, and in various places farther to the north, the same plants flower at Zurich 6 days later than at Parma, at Tubingen 13 days later, at Jena 17, at Berlin 25, at Hamburgh 33, at Greifswald 36, and at Christiana no less than 52 days later than at Parma. In higher latitudes, in districts situated in the north of Germany, the development of vegetation is less retarded than in more southern positions; for the delay of the development of efflorescence between Hamburgh and Christiana amounts to only 3·4 days for one degree's approach towards the north, while that between Southern Germany and Smyrna, which is in the same parallel as the most southern portions of Europe, amounts for the same space to 7·4 days.

The ripening of the fruit also is controlled both by differences in the thermal nature of the season for one and the same place, and by the difference of climate in different latitudes. The wheat-harvest begins in the neighbourhood of Naples in June, in Central Germany in July, in the south of England and in the middle districts of Sweden on the 4th of August; and the barley-harvest takes place at Naples in June, in Central Germany about the end of July or beginning of August, in England on the 14th of August, and in the middle districts of Sweden on the 4th of August. Owing to the comparatively higher temperature which prevails in summer in Sweden, and to the more rapid vegetation there than in England, the wheat-harvest does not take place sooner in the south of England that at Upsala, but occurs about the same time; and barley is 10 days later of ripening in England than in Sweden. For July, in England, has a mean temperature of 60·8° Fahr., and about 62·6° Fahr. at Upsala; and August in England has a mean temperature likewise of about 60·8° Fahr., and in Sweden about the same, namely 60·26° Fahr. If we adopt the observations made during two years in Saxony, we find as the mean result that, from efflorescence to ripeness of fruit, 56 days are required for wheat, 59 for rye, 31 for barley, 45 for oats, and 68 for the potato. According to the observations made in Würtemberg, which were continued for several years, the same period of vegetation required 56·4 days for rye, 42½ for Triticum spelta, 51½ for winter barley, 25 for summer barley, and 25½ for oats.—Mere solar heat, however, never operates alone on vegetation, but always in accompaniment with heat generated by chemical action in the plant and in the soil, and with light, electricity, moisture, and the numerous agents which are brought into play in the course of vital energy and of chemical recombination; and therefore the phenomena of variable seasons and variable climates are very far from being in uniform accordance with those of variable atmospheric temperature. The commencing and most precarious stage of vegetation, from the germination of the seed to the full expansion of the foliage, is, for the most part, at least in such climates as ours, gone through in comparative lowness and unsteadiness of atmospheric heat; and the completing and least derangeable stage, from the formation of the fruit to the falling of the leaf, is gone through in comparatively high and steady temperature of both the atmosphere and the soil. And instead of vegetating seasons of different character capriciously following one another in the same manner as the atmospheric ones, an early immediately following a late and this again immediately following an early, as they would do if they were controlled by mere temperature, a series or succession of early ones is generally followed by a series or succession of late ones. Mr. Gorrie remarks that the vegetating season about Edinburgh commences about the 20th of March, and ends about the 20th of October,—that there 40° is the lowest temperature at which corn will vegetate, and 56° the mean temperature of a good vegetating season,—but that in the Carse of Gowrie, nearly half a degree further north, a good vegetating season seldom occurs, though vegetation there is as forward as in the vicinity of Edinburgh; and this, he adds, is a proof that the progress of vegetation is not dependent solely on temperature. He notes too, as general results, that the wettest seasons are the coldest, and that if very dry seasons are warmer and earlier, vegetation is less vigorous, in consequence of a deficiency of moisture at the roots.—The ways in which heat operates are at once numerous, complex, and recondite; and comprise action throughout the plant in connexion with vital energy, action within the organisms in connexion with electricity and chemistry, action upon the leaves and the epidermis in connexion with light and atmospheric agents, and action within the soil in connexion both with the chemical resolution and recombination of the principles of nutrition, and with the vito-chemical functions of the several parts of the seed and the roots. We have not space to attempt illustrations of these intricate actions; and shall simply refer, in the words of a periodical writer, to a small department of one of them as an instructive instance of the whole. "Solar heat," remarks this writer, "liquefies and refines the vegetable juices; in proportion to that heat, therefore, will be their ascent. Heat also renders liquids capable of holding a larger quantity of salts in solution. These salts form the valuable constituents of vegetables, and are, as it were, their frame-work. We have here an explanation of the rapidity of vegetation in warm weather, and also of the fact that warm seasons mature the finest grain; because in these seasons the ascending sap will hold the greatest amount of salt in solution. The most durable vegetable fibre is generally the product of warm climes; and we have the fact explained upon these principles, because in these climes it will be composed of the greatest amount of least soluble salts."

A remarkable law of vegetation, of great consequence to be well known and understood by cultivators, is the counteractive force of luxuriant growth upon early maturation. In the animal kingdom, the chief influences which accelerate growth at the same time accelerate reproduction, so that the period of puberty is uniformly earlier in domesticated than in wild animals, and in those which are fed plentifully with food, than in those which are scantily supplied; but in the vegetable kingdom, the reverse of this arrangement, to a very considerable extent at least, prevails. Where plants are furnished with an abundant supply of food, their reproductive energies are slowly developed, and flowers and fruits are late in appearing; and when the sup-

ply of nourishment is scanty,—when the plant is starved and death is threatened,—the reproductive energies act with readiness, and flowers and seeds are freely produced. In other words, the scantier the supply of nourishment, the earlier will a plant propagate its kind. Hence seeds which are new or fresh produce plants with more luxuriant foliage, and less inclined to run into flower and fruit, than such as have been kept for some time and are partially spoiled. Pease, for example, are well known to be apt to run to straw where the ground is rich or moist; so that the employment of old ones for seed is, in such cases, the only suitable remedy. But where luxuriance of leaf and great size are the objects sought in any species of garden or farm produce, the newest and most vigorous seeds are eminently suitable,—especially, for example, with turnips and cabbage; old seed producing plants too much disposed to run to flower. The law we have mentioned operates also on the growing plant itself; and occasions a variety of practices in horticulture which, though obviously depending on it, are in general but imperfectly understood by the practical gardener. The transplanting of fruit-trees, for instance, hastens the production of flower-buds. A tree which for years has shown no tendency to produce flower-buds, but which has been exclusively occupied in the extension of its roots and branches, will, upon being shifted from its place, soon exhibit symptoms of a change. The roots by this process have been in part injured, the supply of sap to the tree during the following season has in consequence become diminished, and the plant, ceasing in a great measure to increase its size, hastens to propagate its kind, by the production of flower-buds, and the subsequent display of blossoms and fruit. Again, when a rank growing fruit-tree is engrafted on a slow growing stock, or, in other words, when a tree requiring much sap is compelled to receive its supply through a tree having but a scanty supply, the engrafted branch will come earlier into fruit than if it had always been supplied with abundant nourishment; and this method of accelerating the production of fruit, and termed 'dwarfing,' is particularly serviceable in enabling the cultivator of new varieties to become early acquainted with their respective merits. When fruit-trees are prone to run to wood, gardeners are accustomed to lay bare a portion of their roots during winter; and thereby many of their fibres are destroyed, and the vigour of all greatly diminished; so that the sap during the following summer is transmitted to the branches in less quantity, and the production of fruit-buds is the consequence. In the cultivation of flowering plants, a knowledge of this law and its extensive application may prove of great importance. Sir James Edward Smith, in his Introduction to Botany, mentions that the *Solandra grandiflora*, a Jamaica shrub, was for a number of years cultivated in the English stoves, and propagated extensively by cuttings, each plant growing many feet in length every season, from the abundance of moisture and nourishment, without showing any signs of fructification. At length a pot of it was accidentally left without water in the dry stove at Kew; and, in consequence of this unintentional neglect, the luxuriant growth of its branches was greatly checked, and a flower came forth at the extremity of each. By a similar mode of treatment, the same effect has since been frequently produced; and when the law is once properly understood, its application to a variety of cultivated plants, which are slow in showing flower, must be obvious. In the ordinary cultivation of farms, also, numerous examples of it are frequently occurring. The crops growing on the thinnest parts of the soil, where the nourishment is consequently diminished, are always the first to exhibit their flowers, and to be ready for the sickle; and on ill-managed farms, the harvest is usually much earlier, other things being equal, than in those where the crops are under the influence of a better system. In the management of plantations, the indications of this law may often prove of great value; for wherever we see a tree, in a very young state, exhibiting its flowers and producing fruit, we may anticipate its early decay. The premature formation of fruit-buds is the consequence of a scanty supply of nourishment, arising, it may be, from the roots having been injured, but generally from the plant being placed in an unfavourable soil. The balsam fir, for example, which thrives well on a moist soil, will, if planted on a thin dry soil, begin in a few years to produce cones,—then the bark appears covered with blisters which, when opened, pour forth a limpid resin, and the tree, after languishing a few years, dies. In looking at those decorated villas near a large town, which to the citizen appear so captivating, one may frequently discover the real character of the soil by the premature flowering of the ornamental shrubbery.

The effect of gravitation on the growth and habit of plants, has been the subject of profound speculations and ingenious experiments, on the part of some of the most distinguished phytologists; and, though probably over-estimated or confounded with other effects by its principal advocates, seems to be not only real but powerful. "It can scarcely have escaped the notice of the most inattentive observer of vegetation," says Mr. Knight, "that in whatever position a seed is placed to germinate, its radicle invariably makes an effort to descend towards the centre of the earth, while the elongated germen takes precisely the opposite direction; and it has been proved by Duhamel, that if a seed during its germination be frequently inverted, the points both of the radicle and germen will return to the first direction. Some naturalists have supposed these opposite effects to be produced by gravitation; and it is not difficult to conceive that the

same agent, by operating on bodies so differently organized as the radicle and germen of plants are, may occasion the one to descend and the other to ascend. I conceived that if gravitation were the cause of the descent of the radicle, and the ascent of the germen, it must act either by its immediate influence on the vegetable fibres and vessels during their formation, or on the motion and consequent distribution of the true sap afforded by the cotyledons; and as gravitation could produce these effects only while the seed remained at rest, and in the same position relative to the attraction of the earth, I imagined that its operation would become suspended by constant and rapid change of the position of the germinating seed, and that it might be counteracted by the agency of centrifugal force. Having a strong rill of water passing through my garden, I constructed a small wheel similar to those used for grinding corn, adapting a wheel of a different construction, and formed of very slender pieces of wood, to the same axis. Round the circumference of the latter, which was eleven inches in diameter, numerous seeds of the garden bean, which had been soaked in water to produce the greatest degree of expansion, were bound at short distances from each other. The radicles of these seeds were made to point in every direction, some towards the centre of the wheel, and others in the opposite direction, others at tangents to its curve, some pointing backwards and others forwards relative to its motion, and others pointing in opposite directions in lines parallel with the axis of the wheels. The whole was enclosed in a box and secured by a lock, and a wire-grate was placed to prevent the ingress of any body capable of impeding the motion of the wheels. The water being then admitted, the wheels performed something more than 150 revolutions in a minute, and the position of the seeds relatively to the earth was as often perfectly inverted within the same period of time, by which I conceive that the influence of gravitation must have been wholly suspended. In a few days the seeds began to germinate; I soon perceived that the radicles, in whatever direction they were protruded from the position of the seed, turned their points outwards from the circumference of the wheel, and in their subsequent growth receded nearly at right angles from its axis. The germens, on the contrary, took the opposite direction, and in a few days their points all met in the centre of the wheel. Three of these plants were suffered to remain on the wheel, and were secured to its spokes to prevent their being shaken off by its motion. The stems of these plants soon extended beyond the centre; but the same cause which first occasioned them to approach its axis still operating, their points returned and met again at its centre. The motion of the wheel being in this experiment vertical, the radicle and germen of every seed occupied during a minute portion of time in each revolution precisely the same position they would have assumed had the plants vegetated at rest; and as gravitation and centrifugal force also acted in lines parallel with the vertical motion and surface of the wheel, I conceived that some slight objections might be urged against the conclusions I felt inclined to draw. I therefore added to the machinery I have described another wheel, which moved horizontally over the vertical wheels; and to this, by means of multiplying wheels of different powers, I was enabled to give many different degrees of velocity. Round the circumference of the horizontal wheel, whose diameter was also eleven inches, seeds of the bean were bound as in the experiment which I have already described, and it was then made to perform 250 revolutions in a minute. By the rapid motion of the water-wheel, much water was thrown upwards on the horizontal wheel, part of which supplied the seeds upon it with moisture, and the remainder was dispersed in a light and constant shower over the seeds in the vertical wheel, and on others placed to vegetate at rest in different parts of the box. Every seed on the horizontal wheel, though moving with great rapidity, necessarily retained the same position relative to the attraction of the earth, and therefore the operation of gravity could not be suspended, though it might be counteracted in a very considerable degree by centrifugal force; and the difference I had anticipated between the effects of rapid vertical and horizontal motion soon became sufficiently obvious. The radicles pointed downwards about ten degrees below, and the germens as many degrees above, the horizontal line of the wheel's motion, centrifugal force having made both to deviate eighty degrees from the perpendicular direction each would have taken had they vegetated at rest. Gradually diminishing the rapidity of the horizontal wheel, the radicles descended more perpendicularly, and the germens grew more upright, and, when it did not perform more than eighty revolutions in a minute, the radicle pointed about forty-five degrees below, and the germen as much above, the horizontal line; the one always receding from, and the other approaching to, the axis of the wheel. I would not, however, be understood to assert that the velocity of 250 or 80 horizontal revolutions in a minute will always give accurately the degrees of depression and elevation of the radicle and germen which I have mentioned; for the rapidity of the motion of my wheels was somewhat diminished by the collection of fibres of confervæ against the wire grate, which obstructed in some degree the passage of the water; and the machinery having been the workmanship of myself and my gardener, cannot be supposed to have moved with all the regularity it might have done had it been the work of a professed mechanic. But I conceive myself to have fully proved that the radicles of germinating seeds are made to descend, and their germens to ascend, by some

external cause, and not by any power inherent in vegetable life; and I see little reason to doubt that gravitation is the principal, if not the only, agent employed in this case by nature. I shall, therefore, endeavour to point out the means by which I conceive the same agent may produce effects so diametrically opposite to each other.—The radicle of a germinating seed (as many naturalists have observed) is increased in length only by new parts successively added to its apex or point, and not at all by any general extension of parts already formed; and the new matter which is thus successively added, unquestionably descends in a fluid state from the cotyledons. On this fluid, and on the vegetable fibres and vessels while soft and flexible, and whilst the matter which composes them is changing from a fluid to a solid state, gravitation would, I conceive, operate sufficiently to give an inclination downwards to the point of the radicle; and as the radicle has been proved to be obedient to centrifugal force, it can scarcely be contended that its direction would remain uninfluenced by gravitation. I have stated that the radicle is increased in length by parts successively added to its point; the germen, on the contrary, elongates by a general extension of its parts previously organised, and its vessels and fibres appear to extend themselves in proportion to the quantity of nutriment they receive. If the motion and consequent distribution of the true sap be influenced by gravitation, it follows that when the germen, at its first emission or subsequently, deviates from a perpendicular direction, the sap must accumulate on its under side; and I have found, in a great variety of experiments on the seeds of the horse-chestnut, the bean, and other plants, when vegetating at rest, that the vessels and fibres on the under side of the germen invariably elongate much more rapidly than those on the upper side; and hence it follows that the points of the germen must always turn upwards. And it has been proved that a similar increase of growth takes place on the external side of the germen, when the sap is impelled there by centrifugal force, as it is attracted by gravitation to its under side when the seed germinates at rest. This increased elongation of the fibres and vessels of the under side is not confined to the germens, nor even to the annual shoots of trees, but occurs and produces the most extensive effects in the subsequent growth of their trunks and branches. The immediate effect of gravitation is certainly to occasion the further depression of every branch which extends horizontally from the trunk of the tree, and when a young tree inclines to either side, to increase that inclination; but it at the same time attracts the sap to the under side, and this occasions an increased longitudinal extension of the substance of the new wood on that side. The depression of the lateral branch is thus prevented, and it is even enabled to raise itself above its natural level when the branches above it are removed; and the young tree, by the same means, becomes more upright, in direct opposition to the immediate action of gravitation, nature, as usual, executing the most important operations by the most simple means.—It has, however, been objected by Duhamel (and the greatest deference is always due to his opinions) that gravitation could have little influence on the direction of the germen were it, in the first instance, protruded, or were it subsequently inverted, and made to point perpendicularly downwards. To enable myself to answer this objection I made many experiments on trees of the horse-chestnut and of the bean, in the box I have already described; and as the seeds there were suspended out of the earth, I could regularly watch the progress of every effort made by the radicle and germen to change their positions. The extremity of the radicle of the bean, when made to point perpendicularly upwards, generally formed a considerable curvature within three or four hours when the weather was warm. The germen was more sluggish; but it rarely or never failed to change its direction in the course of twenty-four hours; and all my efforts to make it grow downwards by slightly changing its direction were invariably abortive. — Another, and apparently a more weighty objection to the preceding hypothesis (if applied to the subsequent growth and form of trees) arises from the facts that few of their branches rise perpendicularly upwards, and that their roots always spread horizontally; but this objection may, I think, be readily answered. The luxuriant shoots of trees, in whatever direction they are first protruded, almost uniformly turn upwards, and endeavour to acquire a perpendicular direction; and to this their points will immediately return if they are bent downwards during any period of their growth, their curvature upwards being occasioned by an increased extension of the fibres and vessels of their under sides, as in the elongated germens of seeds. The more feeble and slender shoots of the same trees will, on the contrary, grow in almost every direction; probably because, their fibres being more dry, and their vessels less amply supplied with sap, they are less affected by gravitation. Their points, however, generally show an inclination to turn upwards; but the operation of light, in this case, has been proved by Bonnet to be very considerable. The radicle tapers rapidly as it descends into the earth, and its lower part is much compressed by the greater solidity of the mould into which it penetrates. The true sap, also, continues to descend from the cotyledons and leaves, and occasions a continued increase of the growth of the upper parts of the radicle; and this growth is subsequently augmented by the effects of motion, when the germen has risen above the ground. The true sap is, therefore, necessarily obstructed in its descent, numerous lateral roots are generated, into which

a portion of the descending sap enters. The substance of these roots, like that of the slender horizontal branches, is much less succulent than that of the radicle first emitted, and they are, in consequence, less obedient to gravitation; and therefore, meeting less resistance from the superficial soil than from that beneath it, they extend horizontally in every direction, growing with most rapidity, and producing the greatest number of ramifications, wherever they find most warmth, and a soil best adapted. As these horizontal or lateral roots surround the base of the tree on every side, the true sap, descending down its bark, enters almost exclusively into them; and the first perpendicular root, having executed its office of securing moisture to the plants whilst young, is thus deprived of proper nourishment, and, ceasing almost wholly to grow, becomes of no importance to the tree."

VEGETATION. See Vegetable Physiology.

VEGETO-ALKALIES. See Alkaloids.

VELLA. See Cress-Rocket.

VELLEIA. A genus of ornamental exotic plants, of the goodenia family. Three species, all yellow-flowered, evergreen herbs of between 3 and 8 inches in height, have been introduced to British greenhouses from Australia; and some other species are known.

VELLING. Ploughing up or paring the turf or surface of the ground preparatorily to its being burnt.

VELTHEIMIA. A genus of ornamental, tuberous-rooted, South-African plants, of the day-lily family. Three species, the green-leaved, the glaucous, and the intermediate, all about two feet high, and carrying light flesh-coloured flowers at an early period in spring, have been introduced to the greenhouses of Britain; and they love a soil of rich mould, and are propagated from offsets.

VENISON. The flesh of deer. See the articles Deer and Meat.

VENTILATION. The frequent or constant circulation of pure air in confined apartments, occupied by man, by the lower animals, or by living plants, in sufficient quantity to prevent the accumulation of noxious gases. The necessity and principles of it are widely different in the case of animals and in that of plants; but they are the same in the case of man and in that of the domesticated animals,—the same for human dwellings and for stables and cattle-houses; and while we shall illustrate them in two sets, the one applicable to human beings and the other applicable to plants, we must be understood as saying, with reference to horses, cattle, dogs, and all other domesticated animals, substantially the same things which we say with reference to human beings.

The carbonic acid naturally present in the atmosphere exists just in sufficient quantity to supply food to plants without inflicting any injury on animals; but whenever it acquires considerable increase, in a confined apartment, it becomes highly noxious to every breathing creature. Now during the combustion of wood or coal or any other ordinary fuel, or during the decomposition of straw or any other dead vegetable matter, carbonic acid is formed by the combination of the extricated carbon of the fuel or litter with the oxygen of the air. This acid is formed also by the oxygen consumed in respiration, combining with the carbon in the venous blood, which, having become carbonised in its progress through the arteries for the purposes of life, goes to the lungs to be decarbonised. Thus carbonic acid is given out by the breath, as well as by the exhalant pores of the body, it being supposed that much uncombined oxygen enters the blood, and does not unite with carbon until it reaches the capillary arteries. This formation of carbonic acid in the body engenders animal heat; and oxygen being a supporter of the combustion originated by electrical action—indeed the only supporter of combustion for living creatures—if the formation of carbonic acid actually take place in the capillary vessels, we must, according to the views of Dr. S. Smith, be burning carbon at every pore of our bodies. Though grateful and beneficial to the stomach, though constituting one of the principles of spirit, wine, and every vinous beverage, and though existing as a most wholesome ingredient in the water we drink, carbonic acid is a most deadly poison to the lungs, and, unless largely diluted with atmospheric air, causes instant death to him who breathes it. One adult human being emits through the lungs and pores of the body about 40,000 cubic inches of carbonic acid every day,—an amount the carbon of which would be equal to nearly three quarters of a pound of pure charcoal. Thus four individuals, living and breathing in a room eight feet by twelve, and eight in height, would, in the twenty-four hours, evolve in its space 160,000 cubic feet of carbonic acid, or three pounds of solid charcoal,—a quantity that would deprive the whole of them of life, if all ingress of atmospheric air were prevented. Nor is this all. Certain other gases are constantly emitted from the bodies of living animals, in the form of exhalation or insensible perspiration; and are the chemical products or recombinations of useless, injurious, or morbid and rejected portions of their food and organisms; and escape from their pores, or are thrust out of their system, in a manner strictly analogous to excrementition; and act more or less poisonously on every species of animals, but most of all on individuals of the same species as those by whom they are emitted. The chief of these gases are sulphuretted hydrogen, phosphuretted hydrogen, and ammonia,—substances constituting animal fetor. It is a remarkable fact that hydrogen, which, by itself, is a quiet odourless gas, an antiseptic, a non-conductor of the electric principle, and a positive

electric, is, nevertheless, one of the elements in all compounds generating putrid disease. The sulphuretted hydrogen is a union of hydrogen gas with sulphur, forming an invisible gas heavier than common air in the proportion of 36·764 to 30·8115, and so dreadfully poisonous that one part of it, mixed with 249 parts of air, would destroy a horse if breathed by that animal. Professor Donovan states that a greenfinch died instantly in air containing one fifteen hundredth part of its volume of this gas; and that if the body of a rabbit be enveloped in it, though the head of the animal be exposed to the pure air, it will die in a quarter of an hour. Some individuals give out so large a quantity of this gas, as to discolour white paint. Its odour, when isolated, is that of rotten eggs, it being precisely to the emission of sulphuretted hydrogen that these owe their odious stench. Hydrogen and phosphorus form several combinations equally offensive. The phosphuretted hydrogen is a transparent colourless gas, having, when free, an odour resembling that of putrid fish. Ammonia is largely generated in all animal bodies, and plays a most important part in the dangerous action of animal exhalations upon the human frame. The constituents of it are hydrogen and nitrogen; and the latter of these is the immediate agent of all decomposing action upon organised matter, from the vinous fermentation which, by the decomposition of sugar produces alcohol and vinegar, to the decomposition of dead animal structures by putrefaction. In all these cases the process is the same,—and so is the ultimate result; the action leading, through various changes, to complete dissolution and dispersion of the elements, which enter into new combinations. The nitrogen, in its efforts to liberate itself, having first acted upon the gluten contained in the mucilage of sugar or grape juice, or in malt,—this, in the form of yeast, continues its action upon the sugar, which is converted into wine, afterwards into vinegar, and ultimately into an unwholesome putrid liquor free from either alcohol or vinegar. In like manner, the nitrogen acts as a ferment to dead animal matter, which once in a state of putrefaction communicates its condition not only to any other dead animal matter in contact with it, but to living beings within its influence, producing those dreadful fevers and putrid sores which, in all our large towns, sweep away so many human beings every year; and in some other countries generating that horrible disease called the plague, from which the habits of superior civilisation have freed our island, but to which we were formerly subject from the extremely unclean state of our houses and our persons. The exhalations, then, from human beings, are deadly poisons to human beings, and, in the case of the four individuals shut up in a close room, as we have supposed further up, would engender typhus fever, even if there were nothing to dread from the deadly effects of the carbonic acid and the absence of oxygen. All this shows the necessity of perfect ventilation in our dwelling-houses and public establishments.

When a small close room is occupied for an hour or two by even a single individual, and one too of the most cleanly habits, of the most delicate and fragrant person, any one entering it from the external air will perceive a faint, fetid odour, which certainly does not proceed from the odourless carbonic acid, or the odourless nitrogen; and when several individuals are assembled in such an apartment, the fetid smell is strong and particularly offensive, though they themselves may become insensible to the nuisance. Pastilles are burnt, or perfumes used, to 'purify the air of the room,' as it is alleged; but such expedients only increase the danger; because the pastilles are made of charcoal, sandal-wood, and other perfumes; and the burning of these produces no other effect than to diminish the quantity of oxygen, and increase that of carbonic acid. The atmosphere of a bedroom in which an adult human being has slept, will, in the morning, be found impregnated with a fetid odour, which, from the idiosyncracy of some individuals, is extremely offensive; and this odour is increased by the pernicious practice of not only closing the door and windows, but stopping up the chimney as well, so as to prevent the escape of the offensive gas, at the same time that the fresh air has no power of entering. A large body of assembled men and women, whether consisting of lords and courtly dames at a court drawing-room, or of a mixed congregation in a church, or of the unwashed multitude in a mob, emit the same offensive effluvia, despite of musk, or ambergris, or that most exquisite perfume Ede's hedyosmia, each of which, like every other toilette perfume, carries in its sweets the poisonous carbon. The stench given out by human beings is an agent of death independent of carbonic acid, and one of more fatal import, too, because charged with the germs of infection. It is, in fact, a true putrid ferment, bringing to matter, still possessed of the vital power, the principle of ultimate decomposition. This principle, the cause of the fetor emitted, is a most malignant and destructive poison when reabsorbed by the system; it is nothing less, though in a modified form, than the principle given out by the putrefaction of dead animal matter.

Besides the ultimate elements of animal matter, oxygen, hydrogen, nitrogen, and carbon—elements belonging as much to the snail and the worm as to the flesh of man, or to that of the dog, the tiger, and the elephant, or any other breathing thing—sulphur, phosphorus, ammonia, potash, soda, lime, and many other chemical substances, exist in the human animal structures. Many of these matters are taken into the body with the food, for the purposes of life; and others are obtained by respiration, and by

absorption through the skin. The combinations of sulphur, phosphorus, and nitrogen with hydrogen, are fully sufficient to explain the fetor of animal exhalations. The deadly poisonous sulphuretted hydrogen is largely emitted by some persons in a state of disease, especially by those who have undergone excessive mercurial treatment. As it blackens white lead, the appearance of discoloration on the white paint of a room pretty surely indicates, in the absence of any other apparent cause, an excess of this gas from some individual who has occupied or visited the apartment. The same compound blackens the trinitrate of bismuth, from which the pearl powder of the shops is manufactured. Ladies using this pigment upon their skin should ascertain that they are free from an abnormal generation of sulphuretted hydrogen; otherwise the pearl powder may change from white to a livid lead colour, or even black,—an effect often unjustly attributed to the bad quality of the article. All these offensive and poisonous compounds of hydrogen concur in giving fetor and imparting to animal exhalations a poisonous action distinct from carbonic acid, in the same manner that they create the stench and fermentation of dead flesh. Both kinds of exhalations, those from living bodies and those from dead flesh, are the bearers of putrid and pestilential disease; and a congregation of filthy human beings in a confined space, and deprived of sufficient air, is as certain to generate putrid fever, as the infection from putrid dead bodies. This is the cause of the gaol pestilence, and of the various typhus fevers prevalent in the densely-inhabited dwellings of the poor.

It has been found that young persons in good health are sweeter and evolve generally a less amount of fetid animal exhalations than the middle-aged and the old. The cause of this is obvious: these exhalations in clean and healthy individuals proceed, in a considerable degree, from the excess of nourishment not required for the support of the system, and which is therefore got rid of by the insensible perspiration of the skin. Young people are still growing, if not in height, at least in the various structures of the body, which is not in full maturity till about the age of forty years. A greater amount of nutriment is therefore required to supply in them the secretions of formation. After the age of forty, there are no secretions of formation, but only of continuance; therefore less chyle is required for the purposes of the animal frame. Yet not only is the same quantity of food taken, but often a great deal more. At the maturity of life, and as the body descends the vale of years, people indulge more in alimentiveness; hence an increase of fetid animal exhalations; hence, also, acid digestion and its attendants,—gout, gravel, and a variety of other diseases. That which the system cannot use, it must get rid of; and where, from excess in quantity, the process of getting rid of it is impeded, disturbance must ensue. From this it may be inferred, that the space occupied by young people is, in general, somewhat less impregnated with animal effluvia, than that containing the middle-aged and the advanced in life.

But in addition to the fetid exhalations of healthy persons, there are the still more pernicious exhalations of bodies actually diseased, and of many others which, if not in a state of positive disease, are at least in an unhealthy condition, from excess of pleasure, intemperance in food and drinking, injudicious mercurial treatment, bad habits, or constitutional scrofula in some form or other. Thus, in crowded assemblies, besides the carbonic acid generated, and the exhalations of the healthy portion of the company, the impurity of the air is further increased by the offensive emanations from tuberculated lungs, foul ulcers, and loathsome diseases,—by the fumes of half-digested wine, spirits, ale, and porter,—by the odour of smoked cigars and the meerschaum,—the whole forming a tainted and disgusting compound breathed over and over again by all present. Is it, then, surprising, after dancing to excess in such an atmosphere, after remaining in and breathing it during a considerable number of hours, the muscles fatigued by exertion, the pores of the skin opened and relaxed, every organ of the body affected by the foul air and the unnatural heat, that a delicate girl should be injured by a sudden and violent change of temperature, and from the bracing effect of the fresh air of which she had been so long deprived, should imbibe the germs of a disease that proves so fatal to the young and lovely? Even the most robust are affected by such causes, which no human being can encounter with impunity, but which, on delicate constitutions, are sure to plant the standard of dissolution.

The necessity of ventilation is, therefore, manifest. Air fresh from household contamination ought to be freely admitted in sufficient quantity to carry off all animal exhalations. Carbonic acid, though heavier than air, being expanded by the heat of inhabited apartments, becomes lighter, flows out when its escape is possible, and gives place to a fresh and pure atmosphere. Such ventilation is indispensable not only in crowded rooms and assemblies, but in every apartment occupied by even a single individual. The same degree of ventilation found so useful in public hospitals for the cure of disease, is equally useful in private dwellings for its prevention. The admission, into any room, of the pure atmosphere at a proper temperature never brings disease—quite the reverse; it often removes the cause of disease; and it is a striking fact that the absence of the fresh pure air is the real cause of those various indispositions that are imputed to its presence. Assuredly when the body is overheated, and the vascular action of the skin ren-

dered almost powerless by long sojourn in a close, hot, animalised and carbonised apartment, though only two or three individuals should be present, the lungs and the skin are brought to such a state of morbid susceptibility, that the invigorating and healthy action of the pure atmosphere produces inflammation, often followed by death. It is just like suddenly giving a large quantity of food to a person starved: the effect of treatment so injudicious is death. To restore the body to its normal condition, the air must be administered as gradually as food after starvation; but in both cases the germs of fatal disease often sprout forth ere the remedy can operate. There can be no doubt, then, of the necessity of keeping the air of every inhabited apartment in a state of constant renovation and purity; and that many of the diseases now prevalent, especially those affecting the respiratory organs, and those bearing a typhoid type, are the result of inadequate ventilation. Nor must it be believed that these evils are confined to the small and crowded dwellings of the poor; they are common in the spacious mansions of the wealthy where there is no excuse for them, and where by double doors, green baize, gilt leather, list, and various other contrivances, as much pains are taken to exclude the vital air as would be taken to shut out the pestilential sirocco, or the simoom of the desert. The prevention of cold, and the preservation of a proper temperature, are by no means incompatible with perfect ventilation—quite the reverse; a proper temperature may be best maintained by keeping up a stream of air gently undulating through the apartment, instead of shutting up this so closely that each time the door is opened, a torrent of cold air rushes in, and, until the equilibrium is established, does considerable mischief, by giving colds to those susceptible of taking them,—such susceptibility, in healthy persons, being caused solely by ignorance and bad habits.

There is still a question of great importance, —what amount of space in cubic feet ought to be assigned, in sleeping apartments, to each adult human being? Not less, we reply, than 1,000 cubic feet. Even more would be preferable. A room 18 feet long, 16 broad, and 9 feet high, with a door, a proper-sized window, and a free chimney—closing a chimney being highly injurious—should not be inhabited by more than two individuals. The average allowance in hospitals is from 500 to 600 cubic feet,—a space much too small. In union workhouses the average is only from 200 to 300 cubic feet,—a parsimony of space which greatly increases the demand for pauper medical relief, by rendering the sleeping apartments of the indigent inmates highly insalubrious. The amount of space allowed in stables and cowhouses ought, of course, to correspond in amplitude to the amount allowed in human bedrooms. And the ventilation there, as well as in all apartments occupied by man, should be provided for systematically, by means specially applicable and so contrived as to maintain an equable temperature in every nook and at all hours, and not by make-shifts or by chinky walls or ricketty doors and windows. The fresh air should enter in constant, gentle, minute currents, in equal proportion to the corresponding outflow of foul air, and in such direction or through such contrivances as to maintain the same temperature in the most distant as in the nearest parts of the apartment. Alternations of fresh air and of foul, sudden vicissitudes of cold and heat, and partial currents of cold air through corners or sides of apartments elsewhere full of stagnant warm air, are almost as injurious to both man and beast as a general prevalence of carbonaceous and fetid vapours.

The ventilation of plant-houses does not require to make any provision for either a supply of oxygen to plants or the carrying away of putrefactive fetor from them,—for, during all the period of light, they inhale carbonic acid from the air, and abstract its carbon, and give back its oxygen, so as to reverse the result of animal respiration; and such free or excessive ventilation as is practised in the great majority of hothouses is more frequently injurious than advantageous, and far more suitable to animals than to plants. "Considering the manner in which glass-houses of all kinds are constructed," says Dr. Lindley in his Theory of Horticulture, "the buoyancy of the air in all heated houses would enable it to escape in sufficient quantity to renew itself as quickly as can be necessary for the maintenance of the healthy action of the organs of vegetable respiration. It is, therefore, improbable that the ventilation of houses in which plants grow is necessary to them, so far as respiration is concerned. Indeed, Mr. Ward has proved that many plants will grow better in confined air than in that which is often changed. By placing various kinds of plants in cases, made, not indeed air-tight,—for that is impossible with such means as can be applied to the construction of a glass-house,—but so as to exclude as much as possible the admission of the external air, supplying them with a due quantity of water, and exposing them fully to light, he has shown the possibility of cultivating them without ventilation, with much more success than usually attends ordinary glass-house management. In forcing-houses, in particular, ventilation, under ordinary circumstances, in the early spring, must be productive of injury rather than benefit. Many gardeners now admit air very sparingly to their vineries during the time that the leaves are tender and the fruit unformed. Some excellent stoves have no provision at all for ventilation; and we have the direct testimony of Mr. Knight as to the disadvantage of the practice in many cases to which it has been commonly applied. 'It may be objected,' says this great horticulturist, 'that

plants do not thrive, and that the skins of grapes are thick, and other fruits without flavour, in crowded forcing-houses; but in these it is probably light, rather than a more rapid change of air, that is wanting; for, in a forcing-house which I have long devoted almost exclusively to experiments, I employ very little fire heat, and never give air till my grapes are nearly ripe, in the hottest and brightest weather, further than is just necessary to prevent the leaves being destroyed by excess of heat. Yet this mode of treatment does not at all lessen the flavour of the fruit, nor render the skins of the grapes thick; on the contrary, their skins are always most remarkably thin, and very similar to those of grapes which have ripened in the open air.' While, however, the natural atmosphere cannot be supposed to require changing in order to adapt it to the respiration of plants, it is to be borne in mind that the air of houses artificially heated may be rendered impure by the means employed to produce heat. Sulphurous acid gas escapes from brick flues, ammoniacal vapour from fermenting manure; and there may be many unsuspected sources of the introduction of vaporous impurities; an inconceivably minute quantity of which is enough to deteriorate the air, so far as vegetation is concerned. Drs. Turner and Christison found that 1-10,000th of sulphurous acid gas destroyed leaves in 48 hours; and similar effects were obtained from hydrochloric or muriatic acid gas, chlorine, ammonia, and other agents, the presence of which was perfectly undiscoverable by the smell. We also know that the destructive properties of air poisoned by corrosive sublimate, perhaps by its being dissolved in the vapour of a hothouse, are not at all appreciable by the senses. Ventilation is necessary, then, not to enable plants to exercise their respiratory functions, provided the atmosphere is unmixed with accidental impurities, but to carry off noxious vapours generated in the artificial atmosphere of a glazed house, and to produce dryness or cold or both.

"When the external air is admitted into a glazed house containing a moist atmosphere, it, under ordinary circumstances, is much colder than that with which it mixes; the heated damp air rushes out at the upper ventilators, and the drier cold air takes its place; the latter rapidly abstracts from the plants and the earth, or the vessels in which they grow, a part of their moisture, and thus gives a sudden shock to their constitution, which cannot fail to be injurious. This abstraction of moisture is in proportion to the rapidity of the motion of the air. But it is not merely dryness that is thus produced, or such a lowering of temperature as the thermometer suspended in the interior of the house may indicate; the rapid evaporation that takes place upon the admission of dry air produces a degree of cold upon the surface of leaves, and of the porous earthen pots in which plants grow, of which our instruments give no indication. To counteract these mischievous effects many contrivances have been proposed, in order to insure the introduction of fresh air warm and loaded with moisture,—such as compelling the fresh air to enter a house after passing through pipes moderately heated, or over hot water pipes surrounded by a damp atmosphere, and so on, the advantages of which of course depend upon the objects to be attained. If ventilation is merely employed for the purpose of purifying the air, as is often the case in hothouses and in dung-pits, it should be effected by the introduction of fresh air damp and heated. If it is only for the purpose of lowering the temperature, as in greenhouses, or in the midst of summer, the external air may be admitted without any precautions. But it is very commonly required in the winter, for the purpose of drying the air in houses kept at that season at a low temperature; such, for instance, as those built for the protection of heaths, and many other Cape and New Holland plants: in these cases it should be brought into the house as near the temperature of the house as possible, but on no account loaded with moisture. One of the principal reasons for drying the air of such houses is, to prevent the growth of parasitical fungi, which, in the form of mouldiness, constitute what gardeners technically call 'damp.' These productions flourish in damp air at a low temperature, but will not exist either in dry cold air or in hot damp air. If the air of cool greenhouses is allowed to become damp, the fungi immediately spring up on the surface of any decayed leaves, or other matter which may be present, when they spread rapidly to the young and tender parts of living plants; and when this happens they consume the juices, choke the respiratory organs, and speedily destroy the object they attack. [See the article Mould.] Ventilation is also required in the winter in such places as dung-pits or frames, especially those in which salad, cucumbers, and similar plants are grown. In those cases, the object is to dry the air, in order that the plants may not absorb more aqueous particles than they can decompose and assimilate. Although plants of this kind will bear a high degree of atmospherical moisture in summer, when the days are long and the sun bright, and when, consequently, all their digestive energies are in full activity, yet they are by no means able to endure the same amount in the short dark days of winter, when, from the want of light, their powers of decomposition or digestion are comparatively feeble. Hence, no doubt, the advantage of growing winter cucumbers in forcing-houses, instead of dung-frames. One of the causes of success in the Dutch method of winter forcing is, undoubtedly, their avoiding the necessity of winter ventilation, by intercepting the excessive vapour that rises from the soil, and which would otherwise mix with the air. For this purpose

they interpose screens of oiled paper between the earth and the air of their houses; and in their pits for vegetables they cover the surface of the ground with the same oiled paper, by which means vapour is effectually intercepted, and the air preserved from excessive moisture.

"In forcing-houses, ventilation is thought to be required at the time when the fruit is ripening, for the purpose of increasing the perspiration of the plants, and, consequently, of assisting in the elaboration of the secretions to which fruit owes its flavour. But, even for this, its utility is, perhaps, overrated,—and it is quite certain that it may be easily carried to excess; for, if it is so powerful as to injure the leaves by over-drying the air, an effect the reverse of what was intended will be produced; that is to say, the quality of the fruit will be deteriorated. Upon this subject Mr. Knight has made the following observations:—'A less humid atmosphere is more advantageous to fruits of all kinds, when the period of their maturity approaches, than in the earlier stages of their growth; and such an increase of ventilation, at this period, as will give the requisite degree of dryness to the air within the house, is highly beneficial, provided it be not increased to such an extent as to reduce the temperature of the house much below the degree in which the fruit had previously grown, and thus retard its progress to maturity. The good effect of opening a peach-house, by taking off the lights of its roof during the period of the last swelling of the fruit, appears to have led many gardeners to overrate greatly the beneficial influence of a free current of air upon ripening fruits; for I have never found ventilation to give the proper flavour or colour to a peach, unless that fruit was, at the same time, exposed to the sun without the intervention of glass; and the most excellent peaches I have ever been able to raise were obtained under circumstances where change of air was as much as possible prevented, consistently with the admission of light (without glass) to a single tree.'

"It is not improbable that one of the advantages of ventilation depends upon a cause but little adverted to, but which certainly requires to be well considered. It was an opinion of Mr. Knight, that the motion given to plants by wind is beneficial to them by enabling their fluids to circulate more freely than they otherwise would do; and in a paper printed in the Philosophical Transactions for 1803, he adduces, in support of his opinion, many experiments and observations; of which the following is sufficiently striking:—'The effect of motion on the circulation of the sap, and the consequent formation of wood, I was best able to ascertain by the following expedient. Early in the spring of 1801, I selected a number of young seedling apple trees, whose stems were about an inch in diameter, and whose height between the roots and first branches was between 6 and 7 feet. These trees stood about 8 feet from each other; and, of course, a free passage for the wind to act on each tree was afforded. By means of stakes and bandages of hay, not so tightly bound as to impede the progress of any fluid within the trees, I nearly deprived the roots and lower parts of the stems of several trees of all motion, to the height of three feet from the ground, leaving the upper part of the stems and branches in their natural state. In the succeeding summer, much new wood accumulated in the parts which were kept in motion by the wind; but the lower parts of the stems and roots increased very little in size. Removing the bandages from one of these trees in the following winter, I fixed a stake in the ground, about 10 feet distant from the tree, on the east side of it; and I attached the tree to the stake at the height of 6 feet, by means of a slender pole, about 12 feet long; thus leaving the tree at liberty to move towards the north and south, or, more properly, in the segment of a circle, of which the pole formed a radius; but in no other direction. Thus circumstanced, the diameter of the tree from north to south in that part of its stem which was most exercised by the wind exceeded that in the opposite direction, in the following autumn, in the proportion of thirteen to eleven.' Now, if the effect of motion is to increase the quantity of wood in a plant, it is evident that ventilation, which causes motion, must tend to produce a healthy action in the plants exposed to it; and such a state must also be favourable to the development of all those secretions upon which the organization of flowers, the setting of fruit, and the elaboration of colour, odour, flavour, &c., so much depend. Some suggestions by Mr. Knight, as to the manner in which this result can be artificially produced, will be found in the *Hort. Trans.*, vol. iv. p. 2 and 3; but the subject has as yet attracted little attention."

VENUS'S COMB. See Shepherd's Needle.

VENUS'S FLY-TRAP. See Muscipula.

VENUS'S HAIR. See Maidenhair.

VENUS'S LOOKING-GLASS. See Prismatocarpus and Bellflower.

VENUS'S NAVELWORT,—botanically *Omphalodes*. A genus of ornamental, hardy, herbaceous plants of the borage family. The name alludes to the navel-like form of the seeds.—The evergreen species, *Omphalodes sempervirens*, called by Linnæus *Anchusa sempervirens*, grows wild on rubbishy spots of ground in Britain. Its root is perennial; its foliage is evergreen; its stem is about 30 inches high; and its flowers have a blue colour, and bloom from May till July. Two evergreen perennial species, and four annual species, some with white flowers, others with blue flowers, all very handsome and more or less nearly allied to the hound's-tongues, have been introduced to Britain from the southern parts of Continental Europe; and all thrive well on any common soil.

VERATRIA. See Veratrum.

VERATRUM,—popularly *White Hellebore.* A genus of tall, ornamental, herbaceous plants, of the melanthium family. The white species, *V. album*, is a native of the mountains of Switzerland, Italy, Greece, and Russia, and was introduced to Britain in 1548. Its root is perennial, fusiform, and fleshy, and has strong fibres gathered into a head; its stem is annual, thick, cylindrical, erect, hairy, branching, and from 3 to 6 feet high; its leaves are sheathing, yellowish green, oblong-ovate, plaited longitudinally, and about 10 inches long and 5 broad; its inflorescence has the form of long terminal spikes, consisting of small alternate spikelets, each accompanied with a lanceolate bract; its flowers have a pale greenish-yellow colour, and bloom from June till August; and its fruit are capsules, with many compressed membranous seeds. The whole of the plant is very acrid and poisonous; and the root eminently partakes of the same properties, and has a strong, disagreeable odour, and a bitterish, very acrid, and very prolonged taste, but, in a dried state, wants all the odour and much of the taste, and is used in medicine. The pieces of the dried root in drug shops are either transverse slices of the thick parts or longitudinal slices of the fibrous parts, and have an exsiccated and corrugated appearance, and break with a short starchy fracture; and they have been found by analysis to consist of lignin, gum, starch, acidulous gallate of veratria, a yellow-colouring matter, elaine, stearine, and ammonia. The veratria is a peculiar alkaline principle, but occurs also in colchicum, and appears to be the chief seat of medicinal power, both in veratrum and in colchicum. Powdered veratrum root is a violent sternutatory, emetic, and cathartic, and cannot be safely used, in any form or for any purpose, in either human or veterinary medicine, without the utmost caution. It serves as a sternutatory in cases of lethargy and gutta serena, but requires to be greatly diluted with starch, powdered liquorice root, or some other mild powder; it is useful in the form of ointment, as an external applicant, in some bad cases of ulcerated surface, yet, even in this form, is liable to excite griping and purging; and it acts with more or less advantage, in substance or in tincture, as an internal administration, in cases of leprosy, scabies, epilepsy, and mania, but, if given in overdose, produces hypercatharsis, excessive vomiting, tremors, vertigo, syncope, convulsions, and death,—and even when given in moderate doses, is liable to act with very dangerous violence. A safe dose of it to a strong man cannot exceed two grains, and can be prescribed only by a very skilful physician. The best antidote to an overdose of it is a strong infusion of nut-galls. In veterinary medicine, the powder, in doses of from 20 to 30 grains, acts well as a powerful sedative on the horse, and is sometimes very serviceable in various inflammations, and particularly in inflammation of the lungs; but if given in slight overdose or at an improper moment, it may produce vertigo, tremor, hypercatharsis, and death,—and, it, therefore, ought never to be administered by an unskilful or inattentive practitioner, and far less by a groom or a quack.—Five other species of veratrum, varying in height from 2 to 6 feet, all hardy, perennial-rooted, annual-stemmed herbs, one with white flowers, one with dark purple flowers, and the other three with green flowers, have been introduced to Britain.

VERBASCUM. See Mullein.

VERBENA,—popularly *Vervain.* A diversified genus of corolliflorous exogens, constituting the type of the natural order Verbenaceæ. This order has a botanical place in the vicinity of the Labiatæ and the Scrophularineæ; but is exceedingly diversified in its outward habit and general appearance,—and comprises ugly weeds and brilliant beauties, lowly annuals and imposing shrubs, creeping herbs and lofty trees. A large proportion of the species inhabit wastes, waysides, and woods in Southern Europe and within the tropics. About 160 hothouse species, about 60 greenhouse species, and nearly 40 hardy species, besides very many varieties and hybrids, occur at present in the gardens and botanical collections of Britain; and they are distributed among about 30 genera,—some of the most remarkable of which are verbena, clerodendrum, aloysia, vitex, and tectona.

One species of the genus verbena grows wild in Britain, about 40 have been introduced from other countries, and a few more are known. Some species also which formerly belonged to it are now assigned to three other genera; and many of the most beautiful varieties and hybrids belonging to it have almost as distinct characters, at least to a popular observer, as if they were separate species. Some of the species are hardy annuals; some, hardy biennials; some, hardy, annual-stemmed, erect perennials; some, frame or greenhouse, evergreen, erect herbaceous perennials; and some, either half-tender annual-stemmed perennials, or half-tender evergreen undershrubs, or evergreen herbaceous creepers. Their height varies from an inch or so to 6 or 8 feet; and the extent of the creeping kinds is, in some instances, comparatively great, but depends much on situation and culture. Some have undivided leaves; some, trifid leaves; and some, variously cut and emarginated leaves. A considerable number are mere weeds; and the rest vary in ornamental character from simple beauty to the most dazzling brilliance. The colour of the flowers is generally pervading and uniform in any one species or variety; but it comprises so wide a range as white, sulphur, cream, carmine, pink, red, crimson, scarlet, purple, violet, lilac, and blue throughout the genus.

The indigenous species, or common vervain, *Verbena officinalis*, inhabits road-sides, dry waste grounds, and dry pastures, in the vicinity of dwell-

ing-houses and villages. Though pretty common in almost every district of England, and often very abundant by the side of footpaths, it scarcely ever occurs at a greater distance from a human dwelling than a quarter of a mile; and it used to be called the Simpler's joy on account of its indicating the near neighbourhood of a house. Its root is perennial, woody, and somewhat creeping; its stem is annual, ascending, leafy, roughish with minute bristles, and from 18 to 27 inches high; its leaves are deeply cut; its inflorescence is a sort of panicle composed of several slender spikes; and its flowers are inodorous and bluish or purplish, and bloom from June till September. This plant has scarcely any aromatic or other sensible quality; and though now known to be of little or no value for any medicinal or economical purpose, and to possess the rank as well as the appearance of a mere weed, it formerly had a place in the materia medica, and also bore high fame for some remarkable uses of superstition. Its root, too, was worn about the neck on a string as a charm against the king's evil.

Some of the most interesting of the exotic species are the veronica-leaved, *V. veronicæfolia*, a hardy blue-flowered annual, of 2 or 3 inches in height, blooming in July and August, and introduced from Mexico in 1825; the hispid, *V. hispida*, a hardy, purple-flowered annual of about a foot in height, blooming in July and August, and introduced from Peru in 1816; the elegant, *V. elegans*, a hardy, blue-flowered biennial, of 2 or 3 inches in height, blooming in July and August, and introduced from Mexico in 1826; the hairy-spiked, *V. lasiostachya*, a hardy, purple-flowered biennial, of about 2 feet in height, blooming in July and August, and introduced from California in 1826; the many-spiked, *V. polystachya*, a hardy, annual-stemmed, red-flowered perennial, about 4 feet high, blooming in July and August, and introduced from Mexico in 1820; the sister, *V. sororia*, a hardy, annual-stemmed, purple-flowered perennial, about 2 feet high, blooming in July and August, and introduced from Nepaul in 1824; the strong-veined, *V. venosa*, a frame herbaceous evergreen, about 30 inches high, carrying rose-coloured flowers from May till September, and introduced from Buenos Ayres in 1830; Tweedie's, *V. Tweediana*, a greenhouse herbaceous evergreen, carrying scarlet flowers in autumn, and introduced from Brazil in 1834; the cut-leaved, *V. incisa*, a greenhouse herbaceous evergreen, about 2 feet high, carrying red flowers from June till September, and introduced from Panama in 1836; the fair, *V. pulchella*, a frame suffruticose evergreen, about a foot high, carrying whitish flowers from June till September, and introduced in 1834; the rooting, *V. radicans*, a frame trailing evergreen, about 6 inches high, carrying lilac flowers from June till September, and introduced from Chili in 1832; the germander-like, *V. teucrioides*, a greenhouse herbaceous evergreen, about 2 feet high, carrying white and pink flowers in autumn, and introduced from South America in 1837; the melindres, *V. melindres*, a greenhouse trailing and climbing evergreen, capable of being trained over a large surface, carrying a profusion of brilliant, scarlet corymbosely arranged flowers, and comprising a number of very distinctly charactered varieties.

But some of the still more recently introduced species, together with the best varieties of the old ones and all the choicest hybrids, are the most attractive both to amateur florists and to popular observers; and they constitute, not only a very numerous collection of flower-garden ornaments, but one of the most dazzlingly beautiful in the world. If a selection rather than a collection be wanted, the following may be mentioned as among the best entitled to favour:—Chandler's atrosanguinea is the brightest of the scarlets, and a very free and robust grower. *V. ignea*, is the next in colour, but is rather difficult to keep through the winter; and Croucher's maxima is nearly as dark, with a better habit of growth. *V. Hislopii* is a bright scarlet, with something of the breed of teucrioides in it; and *V. melindres superba*, and *V. latifolia*, are kinds known and esteemed by every one. All the varieties of Tweediana are good; but *V. T. superba* is the best. Of the rose-coloured or pink kinds, Barnsii is the best, as the old incisa is a very straggling grower, and fades very much under a strong sun. Among the purple kinds, *V. Stewartii* is the best; but *V. Charlwoodiana*, *Hendersonii*, and *triumphans* are so much like it, that it is difficult to distinguish the flowers when off the plants; the two first are probably the best, though all four are worth cultivation. The orange-scarlet varieties are a new class of colours; and of these Kyle's *speciosa* and Croft's *formosa elegans* are most worthy of notice. The first has large flowers, with a white centre; and *formosa elegans* is very appropriately named, for it certainly is elegantly beautiful. *V. variegata* is a salmon scarlet, and *mirabilis* is in the same way, but not quite so bright. Of the white varieties, *V. teucrioides* is very much surpassed by Youell's Princess Royal and the Queen. Princess Royal is a very pure white, more so than the Queen, and a plant of excellent habit. The varieties of *V. teucrioides* are very numerous, and most of them sweet scented. *V. T. rosea* is a purplish rose colour; and Girling's *eximia* is a flower of the same character, but two or three shades darker. *Burleyana* might be called variegated, as the flowers open of a deep rose or ruby colour, and change to pale rose, so that there are several colours upon a plant at the same time. *V. Ingramii*, is a fine variety with deep rose-coloured flowers tinged with salmon. *V. Taglionii* is very fine, with immense corymbs of flowers of a silvery palish colour; Rosy Queen, and Mortloch's superb, are of nearly the same colour, and all three

very good. *V. Iveryana* is a rosy purple, very good; and *V. Bishopii* is a purplish rose-coloured kind, which makes a good bed. Of the lavender-coloured varieties, *V. Niellii* is very good, but of a loose habit. *V. Hydeana* is a pale bluish lilac, very distinct; and *V. Vangardii* is of nearly the same colour. *V. Laconii* is a deep bluish lilac, and a very good variety.

The soil required by some of the old kinds is poor, light, and sandy, and that required by others, as well as by some of the hybrids, is rich and loamy, with a large admixture of mould; but any common garden soil, particularly of a light loamy nature, if kept in careful drainage, will suit excellently for most. The annuals and biennials, even the hardiest, are best raised from sowings on a gentle hotbed; the perennials are most readily multiplied from seeds or from radical divisions; and the hybrids and fine varieties increase rapidly from cuttings, planted in sand under a glass, and, in the case of the tender kinds, in a little heat. All the kinds succeed well in the open ground during the summer and autumn months; and most of the chief beauties do admirably either in beds, in patches, or in pots. The trailing and stoloniferous sorts require to be pegged down; and the climbing kinds must be trained on fancy wire trellises.

VERBERINA. A diversified genus of exotic plants, of the sunflower division of Compositæ. Fifteen species have been introduced to the gardens and botanical collections of Britain, principally from the two Indies and the hot parts of Continental America. They vary in height from 2 to 10 feet. Three are evergreen shrubs, five are evergreen herbs, three are annual-stemmed perennial-rooted herbs, and four are annual-rooted herbs; five have alternate leaves, and the rest have opposite leaves; two have respectively white and orange flowers, and the rest have yellow flowers; a few are ornamental, and the rest have a weedy appearance. The marigold-like species, *V. calendulacea*, a yellow-flowered annual of about 2 feet in height, introduced upwards of a century ago from Ceylon, is regarded in India as a medicinal plant, every part of it having a pleasant and somewhat aromatic taste, and either a decoction of it, or the powder of its seeds and leaves, being prescribed in cases of jaundice and of visceral obstruction. The cultivated species, *V. sativa*, a yellow-flowered annual of about 6 feet in height, introduced from India in 1806, is cultivated in its native country for the sake of the oil produce of its seeds. Most of the kinds thrive well in any common soil.

VERDIGRIS,—chemically *Subacetate of Copper*. A green mineral-like substance, used sparingly as a drug in medicine, and extensively as a pigment in the arts. A coarse and common kind of it is manufactured on a large scale in the South of France, by covering plates of copper with the refuse of the grape after the juice has been expressed for making wine,—and afterwards collecting the accretion which forms on the plates, and beating it in wooden mortars, and pressing it down in bags of white leather; but this always contains a greater or less degree of vegetable extractive, and of the stalks and husks of the grapes. A much better kind is prepared in Britain by covering copper plates with cloth soaked in pyroligneous acid, or by exposing copper plates to the fumes of vinegar. Pure verdigris has a beautiful bluish green colour, a foliaceous texture, and a hard and pulverulent consistence; it is quite inodorous, and seems at first contact with the tongue or palate to be nearly insipid, but leaves a strong metallic taste in the mouth; and it consists, according to Dr Ure, of 52 per cent. of acetic acid, 39·6 of peroxide of copper, and 8·4 of water. It is an useful external application, both in human and veterinary medicine, as a mild caustic for cleaning foul ulcers, reducing the callous edges of sores, and consuming fungous growths; and it serves also, in the form of ointment, as a remedy for chronic ophthalmia; but, in internal exhibition, though recommended as a good tonic in such cases as epilepsy in the human subject and farcy in the horse, it is very uncertain and extremely dangerous, and can seldom be wisely preferred by even the most skilful practitioner to some other drug. A safe dose of it for a strong man rarely can amount to half a grain; and an overdose of it proves rapidly fatal, producing hypercatharsis, excessive vomiting, convulsion, palsy, coma, and death. The best known antidotes are albumen and the ferrocyanate of potash.

VERDITER. A blue pigment, found native in Hungary, and also manufactured by decomposing nitrate of copper with chalk. It is an impure carbonate of copper.

VERJUICE. An acid liquor, used as a chief ingredient in a cooling beverage, and for some of the same purposes as vinegar. It may be prepared from gooseberries, from crab apples, from such grapes as are too coarse for yielding good wine, from such acidulous apples as are least fit for cyder, and from any other fruit of similarly sour character, containing a large proportion of either malic, citric, or tartaric acid. A good method of preparing it from ripe gooseberries or grapes is to express the juice without bruising the seeds,—to strain the expressed juice through a cloth, to bottle it, and to expose it uncorked for six or seven days to the sun,—to replace every morning with fresh liquid as much matter as has become converted into froth,—and, when the fermentation has ceased, to decant the liquor into other bottles, and to cork them, and place them in a cool cellar till they are wanted for use. Verjuice thus prepared is in great request in France as the sapid and cooling ingredient of a refreshing summer beverage,—a little of it being well mixed with a little sugar or syrup, and then poured into a glass and filled up with water; and in a state of ready mixture with sugar, it is

sold by the confectioners of Paris under the name of Sirope de Groseilles.

VERMIFUGE. Any medicine which expels intestinal parasites from man or horse or other subjects. One of the best vermifuges for man is turpentine,—for the horse, calomel and aloes,—and for the dog, tin. See the article Worms (Intestinal).

VERMILION. The powdered bisulphuret or deuto-sulphuret of mercury. It is found native in the form of a ruddy sand in some silver mines. and is afterwards purified by repeated washings and other processes; and it is also manufactured on a large scale in the solid form of cinnabar, and afterwards reduced to powder. It is well known as a beautiful and delicate pigment. See the articles Mercury and Cinnabar.

VERMIN. Parasites infesting any of the larger animals. See the articles Louse, Lousiness, and Parasites (Animal).

VERMIN. Any animals, small or great, invertebrate or vertebrate, which prey upon the crops or produce of the garden or the farm. The principal molluscous vermin, together with the best methods of keeping them down or destroying them, are noticed in the article Slug; the principal annelidous ones, in the articles Worm and Earth-Worm; the principal insect ones, in the articles Insect, Ant, Aphis, Butterfly, Moth, Beetle, Fly, Caterpillar, Larva, Grub, and Wire-worm; the principal feathered ones, in the articles Crow, Rook, Game, and Hedge-Birds; and the principal mammalian ones, in the articles Mouse, Field-Mice, Rat, Mole, Hedge-Hog, Weasel, and Polecat. A method of destroying most kinds of vermin by means of any strong ammoniacal liquor is mentioned in the article Ammonia. A writer in the English Agricultural Journal describes a method of destroying rats and mice with phosphorus, which may be regarded as an acceptable addendum to the methods noticed in our article Mouse. "Two years ago," says he, "rats of an extraordinary size and fierceness trooped about this old house at night, with a clatter which a little imagination and the stillness of the hour magnified into charges of cavalry. Young pigs were torn from the sows, and devoured, despite their formidable defence; nor was it possible to calculate anything like the quantity of grain consumed by them. Several plans were tried for entrapping and poisoning; but our ingenuity fell so far short of their marvellous sagacity, that no sensible impression was made upon their hosts, notwithstanding unremitting perseverance. However, having declared a war of extermination against the whole race, I rejoice in being now able to communicate to my agricultural friends in England an easy and certain mode of getting rid of this intolerable nuisance. A little manœuvring may be judiciously used to attract the enemy to a suitable position—suppose any unoccupied room in an outhouse, where they particularly abound. Here they should be fed with any favourite food—fish or malt I believe they are fond of—and then with, not a preparation of arsenic, which they are much too clever to touch, but pills, the size of pease, made of equal portions of wheaten flour and powdered sugar, intimately mixed with one sixtieth part of that weight of dissolved phosphorus—say one quarter ounce phosphorus to one pound of flour and sugar. Cold water should be added to make the mass manageable, and the pills finely rolled in dry flour, and kept secluded from light and air. A couple of pills may be thrown into each rat hole, or any quantity left on a plate in a dark situation, by which the double object is attained of attracting the animals by the luminousness of the phosphorus and preserving it from too rapid evaporation. The pills should be replaced as often as eaten, and that without grudging, as although the slain may not be found, it may be relied on that 'every bullet has had its billet.' Still, in a day or two, many rats will be seen running to water, where they die from excessive drinking. No domestic animal appears to be in danger of eating this preparation, except fowls. Dry weather is most favourable to its successful application, as damp, whether of situation or atmosphere, dissolves and consequently weakens the phosphorus."

VERNAL GRASS. See Anthoxanthum.

VERNONIA. A genus of ornamental exotic plants, of the thistle division of the composite order. About 20 species have been introduced to the gardens and botanical collections of Britain, principally from various parts of America; and nearly 30 more are known. A few of the introduced species are herbs, with sessile and subspicate flowers; a greater number are hardy perennial-rooted, annual-stemmed herbs, with paniculate or corymbose flowers; and five or six are tropical evergreen shrubs. Most have a height of between 3 and 9 feet, and carry purple-coloured flowers, and bloom from the early part or middle of autumn till November; but one of the shrubs, the axillary-flowered, has lilac-coloured flowers, and blooms throughout the greater part of the year. The greater number thrive well in any common soil; and the shrubs are propagated from cuttings, and the perennial-rooted herbs by radical division.

VERONICA. See Speedwell.

VERTIGO. See Megrim.

VERVAIN. See Verbena.

VERVAIN (Bastard). See Stachytarpheta.

VESICARIA. A genus of ornamental exotic plants, of the cruciferous order. The name is derived from a word signifying "a bladder," and alludes to the inflations of the silicles. Four species have been introduced to Britain from Southern Europe and the Levant; and twice as many more are known. Two of the introduced species are hardy evergreen herbs of about a foot in height, the other two are respectively a bien-

nial and an evergreen undershrub; and all the four are yellow-flowered, and bloom in the latter part of spring and early part of summer, and love a soil of sandy loam, and require to be propagated from seeds.

VESICATORY. Any substance or application which blisters or raises vesicles.

VESICLE. An inflated hollow excrescence, in either plant or animal, similar to a blister or a bladder.

VESTIA. An ornamental, deciduous, yellow-flowered, greenhouse shrub, of the nightshade family. It was introduced to Britain from Chili, above 34 years ago; it constitutes a genus of itself, and is specifically called *lycioides* or the boxthorn-like; it has a height of about 3 feet, and blooms in June; and it thrives best in a soil of sandy peat.

VETCH,—botanically *Vicia.* A large genus of ornamental herbaceous plants, constituting the type of a tribe of sarcolobous leguminosæ. This tribe comprises the pea, bean, vetch, chick-pea, tare, everlasting pea, bitter vetch, ochrus, and platystylis genera. The vetch genus has nine united stamens and one free stamen, and is distinguished from all other genera most nearly allied to it by its style having a tuft of hair under the stigma. Nine species of it grow wild in Britain, about 70 have been introduced from other countries, and nearly 40 more are known. Three or four of the species in Britain are erect perennials, about 20 are climbing perennials, and almost all the rest are climbing annuals; nearly one half have pedunculated flowers, and the rest have subsessile flowers; two or three require greenhouse protection, and all the rest are hardy; a good many possess high agricultural value as forage plants, principally under the popular misnomer of tares, and both these and all the others, with scarcely an exception, display a very considerable degree of floral beauty.

The common tare or cultivated vetch, *Vicia sativa,* grows wild by the side of hedges, on the sides of roads, on heaps of rubbish in the vicinity of quarries, and in wettish stony spots of cultivated fields, in many parts of Britain. But, in its wild state, it is much more dwarfish, and has a more slender habit of growth, and has much smoother stalks and leaves than in its cultivated varieties; and, in the latter, it exhibits much diversity of character, and possesses wide diversity of constitutional tone, and is very susceptible of modification from the influences of climate and culture. Its root is annual; its stems are climbing and normally about 3 feet high; its leaflets are oblong, and terminate abruptly with a small point in the middle; its stipules are small and toothed; its flowers are generally in pairs, and have no foot-stalks, and are of a red or purplish colour, and normally bloom in May and June; and its pods are more or less downy or hairy. The most distinct wild varieties of it are the corn vetch, *V. s. segetalis,* and the grove vetch, *V. s. nemoralis;* and the best known cultivated varieties are the winter tare and the summer tare; but all, as well as other varieties, sport and diversify and undergo modifications and almost reverses of their distinguishing characters, when grown and treated for a time in other circumstances than those to which they naturally belong. The winter tare is usually smaller in size, and has more smooth and cylindrical pods, and presents a nearer resemblance to the normal wild plant than the summer tare; and it is suitable to be sown in autumn, and offers complete resistance to the frosts and storms of winter; yet, if repeatedly sown in spring, it rises into comparative luxuriance, and loses most or all of its hardiness, and ceases to be suitable for autumnal sowing. Subvarieties of it, therefore, differ somewhat widely from one another in hardiness and earliness; and a recently introduced subvariety, known in some parts of England under the name of the racers, is said to excel all others, not only in hardiness and earliness, but in bulk of produce and in adaptation to intermixture with rye for the spring-feeding of sheep. The summer tare cannot resist severe frost or other severe winter weather, and requires to be sown in spring; yet it is much more extensively cultivated than the winter tare, and is raised in widely different ways, and for considerably different purposes, or with reference to considerably different modes of application, whether of its herbage or of its seeds. The subvarieties of it are even more diversified than those of the winter tare, particularly in size and luxuriance; and, in many places, the larger kinds are popularly designated vetches, while the smaller kinds are designated tares. The seeds of the winter tare and those of the summer tare, to say nothing of the seeds of the several subvarieties of each, are so like each other as to be indiscriminable by even the most practised judges,—so that much care and confidence are requisite in transactions about them between venders and purchasers. The seeds of another variety, however, the white tare or the Canadian lentil or the Napoleon pea, *V. s. alba,* are very readily distinguishable by their having a white or cream colour and a much milder taste. This variety has a more dwarfish habit, and produces a much greater quantity of seeds than the other varieties; and is cultivated chiefly for the sake of its seeds, and far more extensively in France and in Canada than in Britain. Its seeds are used for human food, both green and ripe, in soups and other dishes, in the same manner as pease; and they are also ground into flour, for intermixture with the flour of wheat, for making bread. A specimen of the herbage of the winter tare was found by Sinclair to be more nutritive than that of the summer; and, when cut at the time of flowering, upwards of one-sixteenth of its entire weight consisted of nutritive principles, between one-

fifth and one-sixth consisted of woody or unassimilable matter, and the rest was water. The cultivation of the chief varieties of the common tare will be discussed after we have disposed of the other species.

The tufted vetch, *Vicia cracca*, is a somewhat abundant native of hedge-banks, plantation-sides, thickets, osier grounds, and low bushy meadows in many parts of Britain. Its roots are perennial, small, and creeping; its stems are furrowed, downy, climbing, and from 2 to 5 feet high, and choke up other plants with their long many-branched tendrils; its leaflets are numerous, elliptico-lanceolate, downy or silky on both surfaces, and of a hoary light bluish green colour; its stipules are half arrow-shaped and mostly entire; its flowers are numerous, and grow in dense clusters, or closely imbricated, elongated, one-sided racemes, and have a bluish or purplish colour beautifully variegated with tints of bright bluish violet, and bloom from June till August; its peduncles or floral footstalks are longer than the leaves; and its pods are smooth and scarcely an inch long, and contain each 4 or 5 dark globular seeds about the size of those of the lentil. This vetch is a good forage plant, and can be profitably cultivated for both its herbage and its seeds; but has not come into much favour among British farmers, probably on account of its pertinaciously climbing habit, and of the difficulty of gathering it. Dr. Anderson speaks highly of it; and Dr. Plot praises it and the wood vetch as the most suitable of all known plants for starved or weak cattle. It yields a considerable bulk of fodder, and is greedily eaten by cattle, and has the important recommendation of containing a much smaller proportion of water than the common tare. Forty-three grains of its nutritive matter comprise 20 of sugar, 12 of mucilage, and 11 of insoluble and saline principles. This vetch thrives best on soils of medium character between stiff and loose, or between clayey and sandy; yet it succeeds well on such light sandy soils as afford sufficient anchorage for its long foraging roots, and on such strong clay soils as are well drained and do not allow a stagnation of moisture about the roots in the months of winter and spring. A specimen of it grown on 360 square yards of the Meadowbank Nursery in the vicinity of Edinburgh began to bloom and had an average height of 2½ feet on the 12th of June, and was ripe and had an average height of from 4 to 5 feet on the second week of August, and was cut at the latter date and thrashed on the 16th of September, and yielded 30lbs. of clean seed, 24 stones of dried haulm, and 2 stones of chaffy refuse separated in the process of thrashing and cleaning. Two very distinct varieties of the tufted vetch occur as ornamental plants in flower gardens,—the one, *V. c. floribus albis*, with white flowers,—and the other, *V. c. floribus rubris*, with red flowers; and an important and very distinct agricultural variety of it is mentioned by Mr. Lawson as having been obtained from France, and as possessing broader and smoother dark green foliage than the normal plant, and yielding a greater quantity of seed, and being about a week later in blooming.

The wood vetch, *Vicia sylvatica*, grows wild in stony places among trees and bushes, on the stony borders of woods and sides of hedges, on the rocky parts of shores and beaches, and even sometimes on strong damp poor clayey soils, in many districts of Britain. It is one of the most elegant of our indigenous plants, and serves well to decorate certain parts of shrubberies, or to train over fences and large trellises. It has similar habits to the tufted vetch, but is more impatient of exposure, and thrives best when supported by shrubs and bushy young trees. Its root is perennial and very slightly creeping; its stems are numerous, much branched, widely spreading, and commonly from 4 to 7 feet high; its tendrils also are large and branched, and combine with the ramose character of the stems to carry the plant over a great extent of supporting surface; its leaflets are elliptical, smooth, and of a light green colour; its stipules are small, sublunate, and bristle-pointed; its flowers have the same kind of arrangement as those of the tufted vetch, and display beautiful variegations of white and blue streaked with grey, and bloom in July and August; and its pods are similar in size to those of the tufted vetch, and have a bright brown colour, minutely dotted. In its natural habitats, particularly in moist woods, it produces a bulk of herbage six times greater than either the tufted vetch or the bush vetch; but when transplanted to any open situation, it produces comparatively little; and, though capable of being advantageously raised from seeds on poor and waste spots where few other forage plants will thrive, and of there producing an amount of herbage somewhat in keeping with its wild luxuriance in moist woods, yet it ripens its pods so irregularly, and drops them as they become ripe so freely, that a good supply of its seeds cannot easily be obtained, and requires to be secured by the slow process of gathering the pods by hand as they arrive one after another at maturity. This plant is superior to many of the commonly cultivated vetches in nutritiveness, and is eaten more readily than any of them by horses, cattle, sheep, and alpacas. A variety of it has white flowers.

The bush or hedge vetch, *Vicia sepium*, grows wild about hedges and in woody places in many parts of Britain; but though naturally loving shady spots, on superior and rather dry soils, in situations favourable to its climbing on bushes and dwarf trees, it thrives well in cultivated fields, and adapts itself to a somewhat wide range of soils, and is by no means so dependent on other plants for support as the tufted and the wood vetches. Its root is perennial and slightly creeping; its stems attain an average height of

about two feet; its leaflets are broad and roundish, smaller toward the point of the leaf, and most abundant toward the point of the shoot; and its flowers stand on such short footstalks as to be subsessile, and grow in clusters of four or six together, and are more numerous at the point of the shoots than in other situations, and have generally a red or violet or dull purplish colour, lightest and slightly striped on the standard, and bloom in May and June. This plant is in general much relished by cattle, and seems well adapted for sowing in mixture with the best wood grasses in such shady places as are not suitable for the clovers; but, as in the case of the wood vetch, a good supply of its seeds cannot easily be obtained. A variety of it occurs with white flowers.

The yellow vetch, or yellow-flowered sea-side vetch, *Vicia lutea*, grows wild on stony and gravelly spots of the sea-coasts of Britain. Its root is fibrous, and varies in duration from annual to slightly perennial; its stem is branching and two or three feet high, and, except when supported by other plants, has a very decumbent or prostrate habit of growth; its flowers have a dull yellowish colour, and bloom from June till August; and its pods are solitary, sessile, reflexed, flattened, broad, and hairy. This plant may be profitably cultivated on such stony and gravelly soils in the vicinity of the sea, as are not capable of bearing any considerable produce of the common clovers.

The narrow-leaved vetch, *Vicia angustifolia*, grows wild in the corn-fields of some parts of Britain, yet seems a doubtful native, and probably was originally introduced from the woods and shady grounds of Germany. Its root is annual; its stems are from 15 inches to 4 or 5 feet high; its leaflets are narrow, smoothish, and of a dark green colour, and terminate abruptly at the points; its flowers are sessile, and grow singly or in pairs, and have a reddish colour, and bloom in May and June; and its pods, when ripe, have a shining black colour. This plant possesses considerable adaptation to field culture for forage; and yields a large bulk of herbage; and is not so easily injured by frost or so liable to early decay toward the end of the season as any of the common summer tares or as any of the clovers; and it is also much less juicy or watery than the summer tare, and therefore not so subject to injury from a long continuance of wet weather.

The other indigenous species are the lathyrus-like, *V. lathyroides*, an annual of from 15 to 24 inches in height, inhabiting fallow-fields, and carrying purple flowers from April till June; the hybrid, *V. hybrida*, an annual of about 20 inches in height, inhabiting thickets, and carrying yellow flowers from June till August; and the smooth-podded, *V. lævigata*, a perennial of from 15 to 24 inches in height, inhabiting sea-shores, and carrying pale yellow flowers in July and August. But the two last are comparatively rare in England, and do not occur in Scotland; and neither they nor the other possess any agricultural importance.

The biennial vetch or Siberian tare, *Vicia biennis*, is a native of Siberia, and was introduced to Britain in 1753. Its root is commonly annual on stiff wet soils, and biennial on porous and comparatively dry land; its stems are slender and branching, and have a height of from 2 to 8 feet; its leaflets are small, smooth, and sharp-pointed, and amount to about 10 or 12 in each leaf; its tendrils are long and for the most part branching; its flowers grow in clusters of about 8 or 10 on long footstalks, and have a light purplish pink colour, and bloom from July till September; its pods are smooth, flattish, and from 1 inch to 1½ inch long and about ¼ inch broad; and its seeds are small, round, and of a dark dull green colour. This vetch was recommended by Miller as an agricultural plant of great promise, so long ago as 5 or 6 years after its introduction to Britain; and it has since been strongly recommended by very competent judges; and it is cultivated on the light soils of some parts of France and Germany; and it possesses the valuable recommendations of growing to a comparatively great height, and yielding a large bulk of herbage, and remaining green throughout the winter in defiance of the most severe weather; yet, to the astonishment of many scientific agriculturists of Britain, it seems never yet to have got a fair trial among our practical farmers. "Those who cultivate it in Germany," says Mr. Lawson, "find it advisable to sow it in mixture with one or other of the melilots, as from its tall and slender habit of growth, unless supported, it is apt to become lodged and much damaged in damp weather; and for this purpose the biennial species of the genus melilotus are exceedingly well adapted, owing to their strong upright habit of growth and similarity of duration."

The bastard tufted vetch, *Vicia pseudo-cracca*, is a native of the South of Europe, and was introduced to Britain in 1820. Its root is annual; its stems naturally attain a height of about 2 or 2½ feet; its foliage is smoother and finer than that of the true tufted vetch; and its flowers have a palish purple colour, and bloom in June and July. This plant makes some agricultural promise; and if it got a due trial, it probably might be found to yield a somewhat large bulk of fodder during the interval between the begun decay of the pastures in autumn and the profitable commencement of the use of turnips and other winter-feed.

The hairy vetch, *Vicia villosa*, is a native of Germany, and was introduced to Britain in 1815. It has an annual root, and naturally attains a height of about 3 feet; and it very much resembles the tufted vetch in at once foliage, flowers, and general appearance; but it is more hairy, and has a more branching habit, and produces a much greater quantity of pods. Mr. Gorrie, who obtained on account of it the High-

land Society's silver medal for the introduction of new or valuable plants into the field culture of Britain, and who sent seeds of it to Mr. Lawson which produced plants of the average height of 8 feet, says, "This plant is quite hardy, and stands the winter; and if sown in October or early in March, it will come into flower in the beginning of July, at which time, although the plants originally should stand 9 inches separate, it will form a dense mass of succulent herbage, of which cattle and horses are exceedingly fond." And Mr. Lawson says, "The *V. villosa* is of slender growth, and relying, like the *V. cracca*, for support on whatever stronger plants may be growing beside it; for which purpose the sweet melilot, *Melilotus cærulea*, or some such strong-growing annual, might be introduced with advantage in the case of this and the other slender-growing annual vetches. It also possesses the same advantages as the *V. cracca*, of containing less watery matter than the common tare, and being greedily eaten by cattle or horses, either in a green or dry state. Compared with the common tare, the *V. villosa*, when sown in spring, comes away rather slower at first; but its actual weight, or bulk of produce from a given space of ground, when fully grown, may be reckoned nearly double that of the other."

The dark purple-flowered vetch, *Vicia atro-purpurea*, is a native of the north of Africa, and was introduced to Britain from Algiers in 1815. Its root is annual; its stems are naturally about 3 or 3½ feet high; its leaflets are slightly villous, and have a dark green colour; its floral footstalks are many-flowered, and not so long as the leaves; its flowers have a dark purple-coloured corolla and setaceous and very villous calyx-teeth, and bloom in June and July; and its pods are short, broad, and pretty well filled, and contain each 3 or 4 seeds. This plant seems to possess good agricultural adaptations in such climates as Italy and the south of France, and probably in the warmest parts of the south and centre of England, but possibly is not hardy enough to be at all suitable farther north.

The Narbonne or broad-leaved vetch, *Vicia narbonensis*, is a native of France, and was introduced to Britain toward the close of the 16th century. Its root is annual; its stems are thick, soft, hollow, much branched, and naturally about 3 feet high, and do not rely much on other plants for support; its leaflets amount to about six on each leaf, and are entire, large, and roundish; its flowers have a reddish purple colour, and bloom in June and July; and its pods are either sessile or have very short footstalks, and grow either singly or in twos or in threes, and are large, flattish, and of a darkish colour when ripe. This plant is cultivated in many parts of Continental Europe, in the same manner in which the common tare is cultivated in Britain. When sown in spring, it yields a close and large crop of succulent fodder, of a strong beany taste, not well liked at first by cattle; and when sown in autumn, it stoutly withstands the severities of our winter, and grows very rapidly in spring, and yields a good bulk of spring forage, which cattle relish better than they afterwards do the first bites of clover.

The three-coloured vetch, *Vicia tricolor*, was introduced to Britain in 1818. Its root is annual; its stems vary in height from about 15 inches to about 3 feet or upwards; and its flowers are sessile, and have a jet black colour on the alæ, a dull brown toward the posterior extremity, and a green colour on the other parts of the corolla, and bloom from June till August. It has a more dwarfish habit than some of the other agricultural annual vetches, but produces a greater quantity of seeds. It was recommended by Mr. Loudon as a plant well worth the attention of farmers; yet, for forage purposes at least, it does not seem to be at all equal to some of the other vetches.

The saw-leaved vetch, *Vicia serratifolia*, is a native of Hungary, and was introduced to Britain in 1723. It so closely resembles the Narbonne vetch as to be considered by some botanists only a variety of it; and its duration, height, floral colour, time of blooming, and several other properties are the same; but its leaves and stipules are deeply sawed or indented, while those of the Narbonne vetch are quite or nearly entire. It is cultivated in the fields of some parts of Continental Europe.

The broad-podded or large-podded vetch, *Vicia platycarpus*, is a native of Germany, and was introduced to Britain in 1723. Its root is annual; its stems are strong, nearly upright, and from 15 to 24 inches high; its leaves resemble those of the Narbonne vetch; its flowers have a purple colour, and bloom in July and August; and its pods are sessile, solitary, large, broad, and inflated. This species and the saw-leaved and the Narbonne differ more or less from all the other species in their comparative independence of support for climbing, in their somewhat strong and robust habit of growth, and in the thickness and succulency of their stems; and they may be regarded as possessing an intermediate character between the common tare and the bean. The broad-podded species, however, yields a much less bulk of produce than either of the other two.

The most likely of the remaining species to adapt themselves to the purposes of the husbandman are the pea-shaped vetch, *V. pisiformis*, a perennial of commonly about 2 feet in height, carrying pedunculated pale yellow flowers in July and August, and introduced from Austria in 1739; the hedge-vetch, *V. dumetorum*, a perennial of commonly about 3 feet in height, carrying pedunculated purple flowers in May and June, and introduced from France in 1752; the Bengal vetch, *V. Bengalensis*, an annual of commonly about 3 feet in height, carrying dark

purple flowers in June and July, and introduced from India in 1792; the intermediate vetch, *V. intermedia*, an annual of commonly about 3 feet in height, carrying subsessile purple flowers in June and July, and introduced from the South of Europe in 1818; the two-coloured vetch, *V. bicolor*, an annual of commonly about two feet in height, carrying subsessile white and purple flowers from June till August, and introduced in 1820; and the Hungarian vetch, *V. pannonica*, an annual of commonly about 20 inches in height, carrying subsessile white flowers in June and July, and introduced from Hungary in 1658.

Most of the annual vetches suitable for field crops are well adapted to cultivation in the intermediate year between different sorts of grain crops, for the double purpose of ameliorating the land and affording a supply of fodder. It has even been contended that vetches may be made the means of enabling the arable farmer to support as much live stock as the grazier,—that, while they remain on the ground, they yield a larger bulk of the best kind of green food per acre than the richest and most productive grass lands,—that they may be taken from the ground at so early a period in the summer as, on the friable loamy soils, to admit of a clean crop of turnips being obtained from the same land in the same year, and of those of the more heavy kinds being sown with wheat,—that while they are capable of being raised with success on most kinds of soils and situations, they support and fatten cattle and sheep of different sizes and breeds in an expeditious manner,—that, in addition to all this, they afford a good preparation for other sorts of green crops, and in that way keep up the successions of such kinds of food for the fattening of additional quantities of animals, and, in consequence, produce abundance of manure in situations where it could not otherwise be procured,—and that, in short, by a judicious combination of vetches with turnips, clover, and sainfoin, the poor downs, sheep-walks, and other waste lands, may be rendered from ten to thirty times more valuable than they are at present. Now though these observations may be unduly sanguine, yet we cannot doubt that the vetch may be beneficially cultivated both for improving the land, and for supporting a larger stock, and that it ought to be more generally grown in most situations, in proportion to the extent of the stock that is kept. When, however, it is grown for the sake of its seed, or when it is allowed to stand till it approaches ripeness, it is one of the most impoverishing of all our commonly cultivated leguminous crops.

Most kinds of soils in ordinary cultivation are more or less suitable for vetches. Gravelly loams of medium dryness are the most generally suitable; and all other loamy sorts, from kinds bordering on thin gravel to kinds bordering on stiff clay, will do. The richer any soil is, provided it be not rankly fertile, the better it is for any vetch crop which is to be cut down in a green state; but a soil of an inferior description is requisite for the seed produce of a vetch crop, as a rich soil sends the herbage of the plant into such excessive luxuriance as to occasion a deficiency in the yield of seed.

The preparation of the land for vetches is done by most farmers in as slim and niggard a fashion as if it were almost wholly superfluous; and certainly less preparation is really necessary in this case than in that of most other farm crops. Yet if a good or especially a very large amount of produce be desired, the soil must be intrinsically rich, and must be well cleaned from both annual and perennial weeds, and must be reduced to a somewhat fine state of pulverization, and, in some cases, must receive a tolerably liberal supply of manure. The quality of the preparation, in fact, very mainly determines the quantity of the produce. Stubble land intended for winter tares ought to be ploughed immediately after the harvesting of the corn crop, and then pulverized by harrowing, and then ridged up before the sowing of the seed; and, though it may do well enough without manure if it be a very rich loam or a rich kindly clay in good condition, yet it ought by all means to be manured either if it be naturally a poor soil, or if it be a rich one in an exhausted state; and should the farmer be so stingy or so hard-pressed as to give it only one ploughing, the manure should be applied on the stubble, —and in the case of sufficient preparation, it should be applied in the second ploughing, at the ridging up of the land. The preparation for spring tares or any other spring-sown vetches should closely resemble that for broadcast pease or for any similar spring-sown green crop; and ought to comprise as much working and cleaning and manuring as a due regard to the aggregate circumstances of the farm will permit. The first ploughing should be given in autumn; and at least a second ploughing, together with harrowing, rolling, and weeding, ought in due course to follow. Manure is requisite on all light and exhausted soils; and should be applied either in a rough and fresh state in autumn, or in a short and well-rotted state before the seed-furrow,—the former method, of course, being the most economical. When the niggard practice of only one ploughing is persisted in, the ploughing should not be given till after the commencement of winter.

The time of sowing depends on the kind of the vetch, the nature of the soil and situation, and the intended use of the crop.—The sowing of the indigenous perennial vetches, in all lands and situations analogous to those of their wild condition, ought to be done as soon as their seeds are ripe, or previous to the advanced stage of autumn; but, on richer lands or in more genial situations, may be deferred till spring. The sowing of winter tares for purposes of forage, on poor soils in late exposed situations, may be as

early as the beginning or middle of August,—on better soils or in more genial situations, in the latter part of August or early part of September,—and on prime soils in the best situations, so late as some time in October. In every case, it should be done in sufficient time to let the plants become perfectly established in the soil before the commencement of winter weather; and, in most cases, especially on well-conducted farms with a large amount of winter stock, it ought to be done at successive periods, through as long a range of time as possible, in order to provide a due succession of green food for spring consumption. The sowing of summer tares for purposes of seed must be done early, else the amount of produce will be deficient; and for purposes of forage, should be done at intervals from February till the end of May,—and has, in some instances of rich soil and warm situation, been advantageously done at so advanced a period as the early part of June. The intervals of time between the sowings, and also the extent of ground sown at each sowing, should be greater in the latter part than in the early part of the succession. The broadcast method, when carefully and evenly practised, is generally the best for forage; and the drill method is generally preferable for seed. No rolling of winter tares immediately after sowing is allowable; but a good harrowing should be given to cover the seeds from being picked up by birds; and, in spring, if the land and the weather be sufficiently dry, a light rolling may be given to the young crop destined for forage in order to smoothen the ground for the scythe; and when this cannot be done, the crop will generally require to be cut with the sickle. A close heavy rolling, immediately after sowing, is commonly suitable for spring tares and other spring-sown vetches, and puts the ground into a fine state for the action of the scythe.

A mixture of some other plants with vetches is desirable or even requisite to prevent them from lying on the ground, and from becoming injured by rains; and, in the case of annual crops grown for forage, serves the additional purpose of making the produce both more abundant and more agreeable. The most suitable intermixing plants are rye for forage winter tares, oats for summer forage tares and for other spring-sown annual forage vetches, melilot for the biennial vetch, pease or beans for summer tares and other annual vetches intended to seed, and beans for winter tares intended to seed and for all the perennial vetches whether intended to seed or to be cut green. Wheat might do as well as rye for the mere supporting of forage winter tares, but is not so well relished by cattle and sheep in its green state as rye, and does not yield such a profusion of early spring feed as any of the prime forage varieties of rye. Barley, on the other hand, might do as well as oats, in the case of summer tares, for the purposes of fodder, but does not afford so good support to the vetch plants by the strength of its culms. Beans greatly improve the quality of vetches, particularly with reference to their seeds, by keeping them well up from the ground, and exposing them fully to the circulation of the air and the play of the sunshine,—and they also facilitate the process of harvesting them; and though their seeds necessarily become mixed with those of the vetches, they are so very different from them in size as to be easily separated in the course of winnowing and riddling. New sowings of beans every year, of course, are requisite for intermixture with the perennial vetches; and, either in the broadcast method or with narrow drill intervals, in consequence of the soil becoming hard and exhausted, the beans will not possess due vigour beyond the second or third year, but will afterwards be dwarfish and feeble; and, in the case at least of the wood vetch, this evil might be partly remedied, by making the drills two feet apart, and working and manuring the intervals for the reception of the beans every year.

The quantity of vetches proper to be sown depends on the kind of the vetch, the character and condition of the soil, the destination of the crop, and the kind and degree of intermixture of other plants. The proper quantity of either winter tares or summer tares, sown alone, in medium or ordinary circumstances of soil and situation, may be from 3 to 4 bushels if the crop be intended for forage, and about $2\frac{1}{2}$ if the crop be intended to ripen its seeds; and the proper quantity of intermixture in average or ordinary circumstances for forage crops, is from 2 to $2\frac{1}{2}$ bushels of winter tares and $1\frac{1}{2}$ bushel of rye, and from $1\frac{1}{2}$ to $2\frac{1}{2}$ bushels of summer tares and 1 bushel of Hopetoun or potato oats. If the quantity sown be too small, the crop may be thin and deficient; and if the quantity sown be too large, the crop may be so crowded in the roots and so feeble in the stems as easily to rot off in wet weather.

The after-culture of vetches which have been sown broadcast consists merely in pulling out the larger weeds, and should be done at an early stage of the crop's growth; and that of such as have been sown in drills, particularly when they are intended to ripen their seeds, consists in the thoroughly cleaning and aerating use of the hand-hoe and the horse-hoe. But, in general, vetches grow so very densely and exert of themselves so smothering an action upon weeds, that they require much less after-culture than most other kinds of green crop. The cutting of forage vetches may be done after the pods have begun to form, but long before the seeds approach to ripeness or even before they are properly formed; or if the cutting take place at an earlier stage of the growth, a second crop will be produced. But in the proportion in which the crop is in an advanced stage at the time of being cut, it impoverishes rather than ameliorates the soil for the cereal crop that is to follow; and to allow

a vetch crop of the early season to stand over for a second cutting may be to forego the far higher advantage of raising a turnip crop on the ground which it occupies. A crop or patch of vetches which stands till its seeds are ripened should be cut and harvested in the same manner as pease.

"In making tares into hay," says Dr. Dickson, "more attention is necessary than in those of most of the artificial grasses, as wet is more injurious to them, and they require more sun and air; but in other respects they demand the same cautious management in order to preserve the foliage from being lost. The time for cutting for this purpose is when the blossoms have declined, and they begin to fall flat. When well made, the hay is of the most nutritious quality. In the application of tare crops, there can be little hesitation in pronouncing that of soiling them with horses or other stock on the farm, as the most advantageous and beneficial method. The vast advantage of this mode is rendered particularly evident by the great loss in converting them into hay. In the practice of soiling much loss may be sustained by cutting the tares at too early a period. An intelligent agricultor is of opinion that the farmer's stock should be wholly supported on them from the time they begin to blow till the blossoms begin to fall off, and the formation of pods takes place. On account of the risk from wet, he recommends that all the stock of a farm should be soiled on them green, as it will have the good effect of taking it off the grass land long enough to allow of its being mown for hay; and by this means the meadow hay be much increased in quantity, and there will not be so much occasion for pasture, the tares abundantly supplying its place. Besides, at the time the cattle return from green tares, the grass land, in the mean time having been mown, may be ready to receive them. It is further observed that, as it would be wasteful in the extreme to turn live stock into a field of tares, as their treading and lying down would do great mischief to the crop, even by feeding it in small patches hurdled off, the most advisable method would be to mow the tares of the first half acre, and to carry the produce into the stables, cow-houses, and fold-yards, or on to poor land to be consumed by stock, then to hurdle the growing tares from such cleared ground, into which put the stock and feed them all with the tares, given to them in racks, removing the hurdles and the racks forward daily to the edge of the growing tares, which will manure the land uniformly, and deposit all the urine in the soil. In the Gloucester Report another good method is recommended, 'which is to feed them through rack hurdles, which are made the same as the common five-railed ones, only leaving the middle rail out, and nailing upright pieces across, at proper distances, to admit the sheep to put their heads through. A swath of vetches being mown in the direction you wish to plough the land, a sufficient number of these hurdles, allowing one to five sheep, are set close to it: at noon the shepherd mows another swath and throws it to the hurdles, and the same at night; next morning, a swath being first mown, the hurdles are again set: thus moving them once in the twenty-four hours, by this trifling additional trouble the vetches are eaten clean off, and the land equally benefited.' In Gloucestershire and Worcestershire, they sow tares as pasturage for horses, and eat them off early enough to allow of turnips being sown the same season. In wet seasons, where the tare crops are large, the stems are, however, apt to become rotten upon the ground; in this condition such food often proves prejudicial to horses; in such cases it will therefore be imprudent to cut them any longer for the purpose of soiling. In Sussex tares are of such infinite importance that not one-tenth of the stock could be maintained without them: horses, cows, sheep, hogs, all feed upon them. The last sort of animals are soiled upon them without any other food. This plant maintains more stock than any other plant whatsoever. Upon one acre Mr. Davies can maintain four horses in much better condition than upon five acres of grass; upon eight acres he has kept twelve horses and five cows for three months without any other food. No artificial food whatever is equal to this excellent plant. They find this crop to be a hearty and most nourishing food for all sorts of cattle. Cows give more butter when fed with this plant than with any other food whatsoever. By one crop of vetches succeeding another, Mr. Halstead, in the same district, insures a crop the whole summer of the best food that can be given to cattle; after this he sows turnips, and then wheat. Where large stocks of sheep are kept, tares are exceedingly useful; for they come in at a time when rye and turnip crops are eaten off, and before the clovers and other grasses are in sufficient forwardness for being turned upon, and afford a seasonable supply of food for ewes and lambs. It is recommended to wait till the tares have gained a sufficient increase of stem before the sheep are turned in, and then to divide the ground by hurdles, in the same manner as is practised above. By this means there will be little waste, and the ground be enriched in a much higher degree than if the stock had been suffered to ramble over the whole crop. As from the great closeness and shade which is produced in these crops the land becomes much improved and rendered more clean and mellow, such plants should constantly be cultivated wherever the soils and situations will admit, especially if the keeping of much live stock be the object. In cold exposed situations, where vegetation is late in the spring months, they are not so proper: it may sometimes under such circumstances be more advisable to raise clover crops, as it will not be so much later as to render it much less valuable, and at the same time be more certain.

Tare crops form an excellent preparation for wheat in all the more strong and heavy sorts of soil, and for both grain and turnips in those of the light kinds; but as they have much effect in rendering the lands on which they grow more light, open, and porous, they may sometimes, in the latter case, bring it into too loose a state for the successful culture of that crop, as it requires a rather close texture of the land."—*Withering's Botany.—Smith's English Flora.—Sinclair's Hortus Gramineus.—Lawson's Agriculturist's Manual.—Loudon's Works.—Dr. Dickson's Practical Agriculture.—Sproule's Treatise on Agriculture.—Annals of Agriculture.—Reports to the Board of Agriculture.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society.—Museum Rusticum.—Young.—Low.—Stephens.*

VETCH (Bitter). See Bitter Vetch.

VETCH (Horse-Shoe). See Horse-Shoe Vetch.

VETCH (Kidney). See Kidney Vetch.

VETCHLING. See Lathyrus.

VETCH (Milk). See Milk Vetch.

VETERINARY MEDICINE. This useful branch of general knowledge in former years, and even now, by the vulgar, called farriery, has of late received the more appropriate and deserving title of veterinary art. In a medical point of view, it may be regarded as naturally allied to the science of human medicine; in other respects, however, its objects tend quite another way; and it is only by a happy amalgamation of acquirements of both descriptions, that veterinary science can be practised with its fullest advantages. The veterinary art, according to the present acceptation of the phrase, comprehends a knowledge of the external form, as well as the internal structure and economy, of our domestic quadrupeds, — their appropriate management,—the nature, causes, and treatment of their disorders,—and the art of shoeing such of them as may be found to require it. The word veterinary is an anglicism derived from the Latin adjective *veterinarius*,—which, by some of the ancient writers, in particular by Columella, was used substantively, to denote a farrier, horse-doctor, or one who lets horses to hire; its radical being the verb *veho*, to carry,—whence veterinarius came to signify anything connected with, or relating to, beasts of burden.

Veterinary science shared the common fate of literature in general during the interval known as the dark ages; and it was not until some time after the period of the universal revival of letters, and other arts and sciences, that the veterinary art once more came to be deemed worthy the attention of men of respectability and education. To the French in an especial degree are we indebted for this meritorious rescue of our art from the trammels of ignorance and superstition. Solleysel, Bourgelat, and Lafosse, shone first in the hemisphere of revived veterinary science, and have left behind them lights which will for years to come serve us as beacons through many obscure and trackless regions. In 1762, the first veterinary school was instituted, the one at Lyons; in 1766, that at Alfort was opened. A similar institution was founded at Berlin in 1792; and, in the year following, the London veterinary college was opened for the reception of pupils and patients, under the direction of Sainbel, its first professor, a Frenchman who had come over from France for the specific purpose of introducing the study of the art among us, and who succeeded, under the auspices of the Odiham Agricultural Society, in founding a college and creating himself professor. See the articles Agricultural Schools and Hippopathology.

An enlightened age has discovered that the study of the medical department of this art can be rationally conducted only upon a knowledge of anatomy and physiology. These are the rocks which the farriers are continually splitting and blundering against; the neglect of this the cause that has led to so much mystery, superstition, and mal-practice among them. When we consider what a complicated machine an animal body altogether is, and how exceedingly its intricacy and importance must be enhanced by the circumstance of its being possessed of vitality, we can only feel astonishment we hardly know how to express, that such a set of ignorant men as farriers and grooms in general are, should have the assurance to pretend to be able to set that machine aright again every time it is out of order, concerning which they possess not one particle of knowledge, in regard either to its construction or its action, when it is in a sound and healthy state. But the truth is, it is this very ignorance which carries them through the darksome wilderness into which want of common reflection alone on the part of their employers could have induced them to enter.

VIBORGIA. A small genus of ornamental, yellow-flowered, Cape-of-Good-Hope, evergreen shrubs, of the genista division of the leguminous order. Two species, the silky and the obcordate, have been introduced to British collections; and they have a height of between 2 and 4 feet, and bloom in July and August, and thrive best in a soil of loamy peat.

VIBRIO. See Ear-Cockle.

VIBURNUM. A genus of ornamental, erect, white-flowered shrubs, of the honeysuckle family. Two species grow wild in Britain, about 30 have been introduced from other countries, and a few more are known. Five or six of the species in Britain are tender or half-tender evergreens, four or five are hardy evergreens, and the rest are hardy deciduous shrubs. They vary in height from 2 to 20 feet; and most love a soil of peaty loam, and are propagated from layers. Three are described in the articles Laurustinus, Guelder-Rose, and Cassine; and two or three more of the best known may be noticed here.

The common viburnum, or wayfaring tree, or pliant mealy tree, *Viburnum lantana*, inhabits the hedges and thickets of Britain and of most other parts of Northern Europe. It commonly has a height of about 10 or 12 feet, and sometimes attains a height of 20 feet or upwards; but, in culture, may be kept down to any height desired. In places where it abounds, it is little esteemed for ornament; but in places where it is rare, it attracts and delights almost as much as the most admired exotic of the shrubbery. The branches are rather few; and, in winter, are covered with a smooth greyish bark, inclining to brown; and are long and exceedingly tough, sometimes shooting six feet from the bottom in the course of a single year, and generally making prime bands for fagotting. The young branches, as they shoot, are white and downy; and their ends, especially in winter, feel soft and woolly. The leaves are opposite, heart-shaped, serrated, of great size, full of large veins, dark green above, and white and cottony below. The flower-buds begin to form in the preceding summer, and increase throughout the autumn and winter, and eventually have the appearance of rough buttons; and about May they begin to divide, and are developed into floral umbels or bunches. The flowers are wholly out in June, and make a pretty good show; and the fruit, which succeed them, are highly ornamental berries, and have at first a fine red colour, and afterwards a deep black. Two well-marked varieties of this species are in cultivation,—the large-leaved and the variegated-leaved; and both are more esteemed in shrubberies than the normal plant.

The saw-leaved or tooth-leaved viburnum, *V. dentatum*, is a native of Virginia, and was introduced to Britain in 1736. Its branches, leaves, and flowers are not so large as those of the common viburnum; but they have a more elegant appearance. It has commonly a height of about 5 feet, but sometimes grows so high as 10. The bark is smooth, and of a light colour. The leaves are opposite, and stand elegantly on longish footstalks, and are roundish, strongly veined, and beautifully serrated, and have a fine light green colour, and are tolerably large, though by no means so much so as those of some of the other species. The flowers come out in very large round bunches at the end of the branches, and bloom in June and July, and are rarely succeeded by fruit in Britain.

The naked or entire-leaved viburnum, *V. nudum*, is a native of North America, and was introduced to Britain in 1752. It has much the appearance of a laurustinus, but is deciduous, and almost twice as tall. The bark of the younger branches is smooth and of a deep red colour; and that of the older branches, though also smooth, has a dark brown colour. The leaves are opposite, entire, ovate-lanceolate, pretty large, much veined, of a beautiful shining green colour above, and paler below. The flowers come out in large umbels at the ends of the branches, and bloom from May till July, and have a handsome appearance, and resemble those of the common laurustinus, but are rather smaller; and they are succeeded by berries, which seldom or never ripen in Britain.

The plum-leaved viburnum or black haw, *V. prunifolium*, is a native of North America, and was introduced to Britain in 1731. It is hardy and deciduous, and commonly about 8 or 10 feet in height. The bark is smooth and reddish. The leaves are chiefly opposite, and stand on shortish footstalks, and are oval, and finely serrated, and not so large as those of most of the other species, and have a pleasant light green colour. The flowers come out in large umbels at the ends of the branches, and bloom in May and June. And the berries have somewhat the appearance of haws, though of a black colour, and occasion the plant to be commonly called the black haw; but they seldom come out in Britain.

VICIA. See VETCH.

VICTORIA REGINA. A magnificently flowering plant, one of the wonders of the vegetable world, belonging to the water-lily family. It was long ago described and figured by the German botanist M. Poppig, under the name of *Euryale amazonica;* but it is very rare, very tender, and very refractory to artificial treatment, and seems to have become generally forgotten among botanists; and, in 1837, it was rediscovered by M. Schomberg, and, by permission of the British Queen, was called *Victoria regina*. "On the 1st of January 1837," says M. Schomberg, "while contending with the difficulties nature opposed to our progress up the river Berbice (in British Guiana), we arrived at a point where the river expanded and formed a currentless basin. Some object on the southern extremity of this basin attracted my attention; it was impossible to form any idea what it could be, and, animating the crew to increase the rate of paddling, shortly afterwards we were opposite the object which had raised my curiosity,—a vegetable wonder. All calamities were forgotten; I felt as a botanist, and felt myself rewarded. A gigantic leaf, from 5 to 6 feet in diameter, salver-shaped, with a broad rim of a light green above, and a vivid crimson below, rested upon the water. Quite in character with the wonderful leaf was the luxuriant flower, consisting of many hundred petals passing in alternate tints from pure white to rose and pink. The smooth water was covered with them; and I rowed from one to another, and observed always something new to admire. The leaf on its surface is of a bright green, in form almost orbiculate, with this exception opposite its axis, where it is slightly bent in. Its diameter measured from 5 to 6 feet. Around the margin extended a rim about 3 to 5 inches high; on the inside light green, like the surface of the leaf; on the outside, like the leaf's lower part, of a bright crimson. The stem of the flower is

an inch thick near the calyx, and is studded with sharp elastic prickles, about three quarters of an inch in length. The calyx is four leaved, each upwards of 7 inches in length and 3 in breadth at the base; they are thick, white inside, reddish brown, and prickly outside. The diameter of the calyx is 12 to 13 inches; on it rests the magnificent flower, which, when fully enveloped, covers completely the calyx with its hundred petals. When it first opens, it is white, with pink in the middle, which spreads over the whole flower the more it advances in age; and it is generally found the next day of a pink colour. As if to enhance its beauty, it is sweet-scented. Like others of its tribe, it possesses a fleshy disk; and petals and stamens pass gradually into each other, and many petaloid leaves may be observed which have vestiges of an anther."

VICUGNA, or VICUNA. See ALPACA.

VIEUSSEUXIA. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris tribe. Eleven species, all about a foot high, and most blooming in May and June, have been introduced to the greenhouses of Britain. About one half have flowers of some shade of red or purple; and the rest have them either white, cream-coloured, yellow, greenish, or variegated. All love a soil of sandy peat; and the majority are propagated by radical division. Most were formerly comprised in the iris and moræa genera.

VIGNA. A beautiful, twining, yellow-flowered, hardy annual plant, of the kidney-bean division of the leguminous order. It is a native of North America, and has long been known in Britain. It attains a height of about 4 feet; and blooms in July and August. It constitutes a genus of itself, and is specifically called *glabra* or the smooth.

VILLARSIA. A genus of ornamental aquatic and marsh plants, of the gentian family. The water-lily-like species, *Villarsia nymphoides*, called by Linnæus *Menyanthes nymphoides*, is a floating, yellow-flowered perennial, of the rivers of some parts of England, somewhat resembling the buck-bean, and blooming in June and July. The cordate species, *V. cordata*, is a hardy, floating, yellow-flowered perennial, introduced in 1820 from North America. Four or five other floating species, and three or four upright, evergreen, marsh species, all more or less tender, and most carrying either yellow or white flowers, have been introduced to the botanical collections of Britain from South America, Southern Africa, and Australia. The cordate species is propagated from offsets; and all the others from suckers.

VILLOUS. Covered with soft, close, long, loose, hairs, of a silky, woolly, or shaggy appearance. The epithet is botanical.

VIMINARIA. A small genus of ornamental, yellow-flowered, Australian, evergreen shrubs, of the sophora division of the leguminous order. Two species, the stripped and the side-flowering, both about 3 feet high, and blooming from June till September, have been introduced to Britain; and they love a soil of sandy peat, and are propagated from cuttings.

VINCA. See PERIWINKLE.

VINE,—botanically *Vitis*. A genus of thalamiflorous, exotic climbing plants, constituting the type of the natural order *Ampelideæ*. This order is botanically akin to the geranium and the bead-tree families; and, as to the habit of very many of its plants, is ill or not at all represented by the common grape vine. About 20 hardy ligneous species, 7 or 8 greenhouse species, and nearly 40 hothouse species, at present in the gardens and botanical collections of Britain, belong to it, and are distributed among the genera vitis, ampelopsis, cissus, and leea. Upwards of a dozen of these species are true vines; and about as many more unintroduced ones are known. All the vines are ornamental; and all likewise produce grape-like fruits; but the grapes only of *Vitis vinifera*, are pleasantly esculent, or produce good wine-making juice,—those of the best of the others having a disagreeable foxy flavour, which is not removed by cultivation. Three of the introduced species are tropical evergreen climbers, and the rest are hardy or half-hardy deciduous climbers. Those from North America generally love a soil of sandy peat, and those from other countries a soil of rich mould; and, excepting the wild vine or *V. labrusca*, all are most readily propagated from cuttings. The typal species is the subject of our article GRAPE-VINE; and two or three of the best known of the other species may be noticed here.

The wild vine, or wild Virginian grape, *Vitis labrusca*, is a native of many parts of North America, and was introduced to Britain in 1656. Its stems commonly climb to a height of 10 or 12 feet; its leaves are large, indented, downy below, and nearly divided into three lobes, but nevertheless of a heart-shaped appearance, and very massive and handsome; its flowers come out in bunches, like those of the grape vine and have a herbaceous colour; and its fruit are spherical, black, and rough-flavoured. But a variety introduced in 1805, *V. l. baccis albis*, has white fruit. If the wild vine be wanted as an ornamental climber in the open ground, it should be planted among trees or pretty large shrubs; for, by the assistance of its well-holding tendrils, it will attain a great height; and, if the shrubs which grow near it be low-growing ones, it will entirely overtop them, and, in summer, almost conceal them with its foliage. This species is most readily propagated by layering.

The crumpled or parsley-leaved vine, *Vitis laciniosa*, is a native of Canada, and was introduced to Britain in 1648. It commonly attains a height of 20 or 25 feet; and it has herbaceous coloured flowers, and blooms in June and July. Its stem is very thick, and its shoots are strong, so that when it is planted for an ornamental out-of-door climber, it must be placed in the vicinity

of tall and very powerful trees, as it would quite choke and overwhelm slender trees or mere shrubs. Its leaves are finely divided; and, when seen at a little distance, resemble those of parsley, but are larger.

The summer vine or fox grape, *Vitis æstivalis*, is a native of Virginia, and was introduced to Britain in 1656. Its stem attains about the same height as that of the crumpled vine; its leaves are large, heart-shaped, indented, and smooth on both surfaces; its flowers are green, and come out in vine-like bunches; and its fruit are black, and have in a high degree the odious flavour like the smell of a fox. A variety of this species, *V. æ. sinuata*, is only about half the height of the normal plant, and has sinuate leaves.

VINEGAR. Impure and diluted acetic acid. It was known in very early times and in far distant countries, and was used by the ancients in mixture with water as a cooling beverage, and made a figure in commerce long before the economical use of any other acid. Various and widely different kinds of it seem also to have been early known. A kind called pesca or sera, almost or quite identical with weak soured wine, is supposed to be the vinegar which was offered to Ruth by Boaz and to the Saviour by the Roman soldiers; and a very sour or strong kind seems to be referred to in the two passages in Proverbs, "As vinegar to the teeth, and as smoke to the eyes, so is the sluggard to them that send him"—"And as vinegar upon nitre, (or rather upon natron or native soda,) so is he that singeth songs to an heavy heart." The latter passage also intimates that the Hebrews knew well the neutralizing power of an alkali upon an acid,—or at least the power of soda to destroy the sourness of vinegar; and a passage in the Pentateuch,—"He shall drink no vinegar of wine or vinegar of strong drink, neither shall he drink any vinegar of grapes"—intimates that they made their vinegar from different sources, and had extensive practical acquaintance with both the acetous and the vinous fermentations.

The varieties of vinegar, as to both method of preparation and intrinsic quality, multiplied with the progress of art and the discoveries of science, till they have become absolutely innumerable. All originate in the process described in our article Acetous Fermentation; and all consist of acetic acid and water, together with one or more or many vegetable principles or extracts either spontaneously present or artificially intermixed. See the articles Acetic Acid and Pyroligneous Acid. All the common vinegars of commerce, with the exception of the clear or pyroligneous ones, are made variously from wine, cider, malt liquor, infusions of malt, saccharine vegetable juices, watery solutions of sugar, and some other and similar liquids; and the chief vegetable principles which they contain are mucilage, extractive, bitartrate of potash, and some acids, essential oils, and colouring matters. "Vinegar," say our commercial people, "can be made in a cheap manner from refuse materials which are frequently thrown away as useless,—such as the husks of grapes, decayed raisins, the lees of wine, grounds of ale, grounds of beer, all the summer fruits of England, even blackberries, and all the refuse washings of a sugar-house, cider-pressings, and the like,—anything, in fact, which contains sugar, or which with the aid of water, air, and warmth, will pass into the acetous fermentation."

The best common vinegar of vinous countries is made from the lees of wine worked up with new wine; and the best of Britain is made from an infusion of malt, and always has a deeper colour than any good wine vinegar. But four very good kinds of household vinegar, perfectly suitable for pickling and for other domestic purposes, may easily be made from respectively honey, brown sugar, British wines, and sour ale, according to the following recipes:—First, as to honey or white vinegar, dissolve three quarters of a pound of honey in rain-water, and put it into a seven-gallon cask, with a quart of malt spirit; shake it well, then fill up the cask with rain-water; shake it again and place it near the kitchen fire, where it must stand without being moved or shaken. Let it remain five months in this place, and the vinegar will be made. Draw it off by piercing the lower part of the cask; and let it run until the concretion which is formed at the top, and is termed 'mother of vinegar,' begins to appear. You may then begin the process again without cleaning the cask.—Second, as to vinegar from sugar:—To eighteen gallons of water put eighteen pounds of very coarse brown sugar; let it boil in an iron boiler, removing the scum until no more rises; pour it into a large tub to cool, and when cold enough to work, put into it a large piece of toasted bread saturated with yeast, washing the toast well in the liquor; after it has fermented three days, beat the yeast well into the liquor, put it into a cask and place it near the kitchen fire, laying a bit of wood over the bung-hole. If in four months it is not sour enough, let it remain a month longer; then rack it off into a fresh cask, and throw into it a handful of shred isinglass; this will fine it, when it may be drawn off and bottled. Half this quantity, or even five or seven gallons, may be made, but the vinegar is always best when made in the first proportion.—Third, as to vinegar from British wines:—Take a new five-gallon cask, and pour into it, boiling hot from the fire, a quart of the best and strongest white wine vinegar, which you have boiled for this purpose in a stone pitcher; bung the cask close, and roll it about until the whole of its surface has been covered with the vinegar, and this latter has become cold; let it stand six hours, then take it out and place the cask in a convenient place by the side of the kitchen fire; bung it up tightly, then bore a hole close to one of the ends where the head is inserted; into this hole

introduce a funnel, and with its aid pour into the cask two quarts of the strongest white wine vinegar; on that day week add a quart of any British white wine that may be dead or sour or unfit for drinking, but which is still on the lees; in a week more add another quart of wine, and so on every eight days, until the cask is full. Let it now remain a fortnight, and the whole five gallons of vinegar will be found of the same strength as that first put in. Now draw off two-thirds, and bottle it; and begin again adding a quart of wine every week.—Lastly, as to vinegar from malt:—Put ten gallons of very stale ale into a cask near the kitchen fire, or in any other warm place; pound five drachms of cream of tartar, the same quantity of alum, and six drachms of bay salt, very fine; boil three quarts of the ale in an iron saucepan, and, whilst boiling, throw into it the powdered materials; the instant they are dissolved, pour the boiling liquid back into the cask; put a double fold of wet brown paper over the bung-hole. In a very short time the contents of the cask will be converted into vinegar.

A few of the best known or most approved fancy vinegars, so flavoured by aromatic herbs and pungent vegetable substances as to impart peculiar piquancy to pickles and sauces, may be made according to the following recipes:—For garlic vinegar, peel some cloves of garlic, then weigh out two ounces; just break the garlic in a mortar, and put it into two quarts of vinegar, to which add also a dozen cloves, and a nutmeg cut into very thin slices. In a month the vinegar will be fit for use; it may indeed be used in a fortnight, but it will not be so good. The jar must be closed with cork and bladder.—For vinaigre printannier, or spring vinegar, about the beginning of June, gather a quantity of cresses, chervil, pimpernel, parsley, and some marigold flowers; dry them in the sun, and put them into a two-gallon stone jar with a wide mouth, which fill up to the brim; put in also six onions, ten shalots, and as many cloves of garlic all peeled,—likewise a dessert-spoonful of white mustard seeds, twenty cloves, half a drachm of mace, a drachm of Jamaica pepper, the same quantity of black pepper, and a lemon sliced with its rind; fill the jar with strong vinegar, tie a bladder over it, and let it stand in the sun during a fortnight,—or if the season be rainy, let it stand by the kitchen fire. At the expiration of that time, run it through a jelly-bag, pressing the bag well out, and bottle it in pint bottles. Cork the bottles well, and tie bladders over the corks.—For shalot vinegar, skin a dozen and half of shalots, and cut them into halves; put them, with a small blade of mace and half of a sliced nutmeg, into two quarts of vinegar; close the jar with cork and bladder, and in a month it will be fit for use.—For cucumber vinegar, peel and slice twenty large cucumbers; put them into a stone jar, and add half-a-dozen onions cut into quarters, four shalots, three cloves of garlic, three ounces of salt, half an ounce of pepper, half a teaspoonful of cayenne, and a lemon sliced with its peel; pour two quarts of vinegar upon these ingredients and let them stand a week, the jar being covered with bladder; then place the vessel in a boiler of hot water, and make a few holes in the bladder with a large skewer; let the water boil during an hour; take out the jar, let the vinegar get quite cold, and pass it through a jelly-bag, which must be well pressed. Put the vinegar into pint or half-pint bottles, and tie the bladder over the cork.—For chili vinegar, bruise three dozen of small green chilis with a little salt; put them into a half-gallon jar, which fill two thirds full of large capsicums; fill the jar with vinegar; let it stand a month, then bottle it in small bottles; put a couple of dozen more chilis bruised with salt, and fill up the jar again with vinegar, which at the end of another month may also be bottled.—For tarragon vinegar, fill up loosely a one-gallon stone jar with the fresh leaves of tarragon just gathered; then fill the jar with vinegar; cork the vessel, tie a piece of bladder over it, and let it stand by the kitchen fire, or, if the weather be fine, in the sun, during a month, when it must be run through a jelly-bag, and bottled for use.—For vinegar of roses, fill a gallon jar with rose leaves just gathered, and put in also two ounces of lump sugar in lumps; then fill the vessel with the very best white wine vinegar; close the jar with cork and bladder, and let it stand in a warm place during a month; run it through a jelly-bag, and bottle it in small bottles.—For orange flower vinegar, put a quarter of a pound of orange flowers into a jar; pour upon them two quarts of vinegar; let it stand a month; then strain and bottle it.—For vinegar of elder flowers or clove gilliflowers, dry in the sun during three days, two ounces of either of these flowers; pour upon them a quart of vinegar and let it stand six weeks.

The vinegar suitable to be used in medicine is either distilled wine vinegar, distilled malt vinegar, or purified and diluted pyroligneous acid. The last of these, also, under the name of white or clear vinegar, is very suitable for many culinary purposes, and has, for a number of years past, very generally superseded all other vinegars in matters of every kind which require the presence of the mere acetic acid without the aroma or sapidity or qualifying action of intermixed vegetable principles. Wine or malt vinegar is used in human medicine internally as a tonic, a refrigerant, a diaphoretic, a diuretic, and an antidote to narcotic poisons, and externally as a moderate stimulant and astringent; any common kind of vinegar is much used in veterinary medicine, either alone, diluted, or in mixture with other substances, as an application to bruises, strains, swellings, and other topical in-

juries and maladies; and wood vinegar, or diluted pyroligneous acid, is used in human medicine externally as a rubefacient, an epispastic, an escharotic, and an antiseptic.

VINERY, or Grape-House. A vinery with two furnaces is generally 50 feet in length, and 14 or 15 feet in width within; the height of the back wall being 10 or 12 feet, and of the parapet about 18 inches. When one furnace only is employed, the length of the house should never exceed 30 or 35 feet. The parapet wall is generally supported on small arches or lintels, so that the vines which are planted inside the house may send abroad their roots in search of suitable nourishment. Sometimes the vines are planted without, and introduced through slanting apertures. Very commonly the roof is formed of sashes, which can be let down for the admission of air. In a grape-house described by Mr. Knight, (*Hort. Trans. Lond.* vol. i. p. 100,) the air is admitted at the ends, where all the sashes are made to slide; a free current may thus be made to pass through the house. Besides, about 4 feet of the upper end of every third light of the roof is made to lift up, being attached by hinges to the wood-work on the top of the back-wall; and in this way, air is given in hot and calm weather, without any additional shade. See the article Ventilation.

In planting a new grape-house, the young vines are put in in February or March, and little or no fire heat is given; they make strong shoots the first year, but only such as are wanted for the trellis are preserved, perhaps three on each plant, and in general these are trained straight towards the roof, ten or twelve inches separate from each other. In September, if the wood be not properly ripened, a little fire heat is given for this purpose. Next year a good deal of fruit begins to appear; but only a few bunches are permitted to come forward, in order to prove the kinds. In the third year, if well managed, they fill the roof; and if the wood be thoroughly ripened, they may be considered as established plants.

We shall here mention an incomparably more speedy mode of storing a new grape-house, which may be adopted wherever a vinery previously exists in the garden, or where there is a friend's vinery in the neighbourhood. In the end of June or beginning of July, when the vines have made new shoots from ten to twelve feet long, and about the time of the fruit-setting, he selects any supernumary shoots, and, loosening them from the trellis, bends them down so as to make them form a double or flexure in a pot filled with earth, generally a mixture of loam and vegetable mould; taking care to make a portion of last year's wood containing a joint pass into the soil in the pot. The earth is kept in a wet state; and at the same time a moist warm air is maintained in the house. In about a week or ten days, roots are found to have proceeded plentifully from the joint of last year's wood, and these may be seen by merely stirring the surface of the earth, or sometimes they may be observed penetrating to its surface. The layer may now be safely detached. Very frequently it contains one or two bunches of grapes, which continue to grow and come to perfection. A layer cut off in the beginning of July generally attains, by the end of October, the length of fifteen or twenty feet. A new grape-house, therefore, might in this way be as completely furnished with plants in three months, as by the usual method, above described, in three years. Supposing the layers to be made on the first of July, they might be cut, and removed to the new house on the 9th: by the 9th of October, the roof would be completely covered with shoots, and next season the house would yield a full crop of grapes. It is not meant that they should be allowed to do so, if permanently bearing plants be wished for: on the contrary, they should be suffered to carry only a very moderate crop, as it is pretty evident that the roots could not sustain the demand of a full one; or at any rate, that the plants would necessarily show their exhausted state by barrenness in the following season. By this means the more delicate kinds, as the frontignac, may be quickly propagated: we have seen layers of the Gibraltar or red Hamburgh made in the beginning of July, reach the length of thirteen feet before the end of the month, yielding at the same time two or three bunches of grapes. The more hardy, such as the white muscadine, form still stronger plants in that space of time. Little difficulty is experienced in removing the plants from the pots into the holes prepared for them: if there be fears of preserving a ball of earth to the new roots, the pots may be sunk with them, and then broken and removed; or the plants may be kept in the pots till autumn, when they may very easily be taken out of them without detriment. When it happens that too much bearing wood has been trained in, the plants are relieved, and sufficient sun and air admitted, by thus removing two or three shoots; and supposing these to contain each several bunches, of some fine sort of grape, they are not lost, but may be ripened, by setting the pots on the side-shelves, or flue trellis of the pinery, or any hothouse.

The proper management of the grape-house has now become an important part of the duty of a gardener. To lay down particular rules in this place is impossible; a few general hints only can be given. A great deal of useful information on this subject may be found in the excellent 'Treatise on the Culture of the Vine,' by Mr. William Speechly, London, 1789; and in the 'Forcing Gardener,' by Mr. Walter Nicol, Edinburgh, 1809. These and similar books the gardener should study, as containing the results of experience; but many cases will occur, in which he must depend on his own practical know-

ledge, and be guided solely by his own judgment.

The forcing of the earliest grape-house is often begun in January. Till all the buds be broke, air is daily admitted by the sashes, and the heat is kept moderate, so that the thermometer may indicate only 50° or 55° in the mornings and evenings when the sun has no influence. The temperature is then gradually raised, in the course of a fortnight or three weeks, to about 70°. When the flowers appear, it is increased nearly to 75°, and the house is frequently steamed, by sprinkling water on the flues, or on the walk when the sun shines, grapes being found to set best in a strong moist heat. The gardener now selects his bearing wood for next year, and trains the shoots to an upper trellis, a foot above the other, and the wires of which are perhaps two feet apart; while he nips off all lateral and superfluous produce, and at the same time shortens the bearing shoots at an inch beyond the uppermost cluster. While the berries are swelling, water is moderately given. Nicol, indeed, recommends that it should be given liberally till they begin to ripen; but this has been considered as likely to deprive the grapes of their proper raciness and flavour.

The thinning of the bunches deserves attention. This is sometimes neglected; but in many kinds, without this attention, the berries in the middle of the bunch are apt to get mouldy and to rot; and in all cases where thinning is practised, the berries become larger and more equal in size. In the operation of thinning, particular care should be taken that the left hand, with which the bunch is held, be kept cool, and also quite free from perspired matter. For this purpose, the gardener should have a vessel with pure cold water beside him, into which he may now and then dip his hand, to keep it cool and clean. Without this precaution the berries often suffer from being handled, acquiring a rusty diseased look, and not swelling freely.

When the grapes approach maturity, all are agreed that no more watering is proper. Most, however, freely admit air. In general, a proportion of the foliage, especially on the stubs on which the clusters hang, is removed. The fruit ought to remain till it be fully ripe; but this the impatience of the owners seldom permits. When the fruit is all gathered, the stubs which bore it are cut off, and the new shoots are let down from the upper trellis to their proper places. Watering both of border and foliage is now resumed, and the house is usually left fully exposed to the atmosphere. The general pruning is performed from the middle to the end of October, and time is thus given for the healing of the wounds before forcing be again commenced. At this pruning the loose part of the outer bark on the old wood is carefully peeled off, and the whole plant and the trellises are washed with some penetrating liquid, calculated to destroy the minute eggs of insects. For about a fortnight after this severe pruning, the house is kept shut, but it is afterwards freely exposed as before.

The management of the late grape-house entirely resembles that of the early, making due allowance for the difference of season. It is not intended for *forcing* the fruit, but merely for supplying the deficiencies of our natural climate in spring and autumn. As the vinery may remain without its glass-covers for many months in the year, in some places, especially in the south and west of England, the peach-house is formed exactly of the same dimensions; and, when the peach season is over, the glass frames are transferred to the vinery, and, if the blossoms have escaped, a crop of ripe grapes, of the best sorts, is thus procured in September or October, and the new wood is thoroughly ripened.

VINEYARD. A plantation of vines.

VINQUISH. See Pining.

VINTAGE. The harvesting of a vineyard, or a crop of grapes.

VIOLET, — botanically *Viola*. A large and interesting genus of ornamental thalamiflorous plants, constituting the type of the natural order Violarieæ or Violaceæ. This order is very nearly akin to the Polygaliæ, to the Droseraceæ, and especially to the Passifloræ; and is distinguished from the Polygaleæ by its stipulate leaves, its two-celled anthers, and its unilocular fruit,—from the Droseraceæ by its involutive exfoliation, its stipulate leaves, its solitary style, and its lengthened embryo,—and from the Passifloræ by its stigmas being one and not three, by its anthers being attached along their whole length and not fixed merely by the middle, by its stamens being hypogynous and not perigynous, by its fruit being capsular and not berried, and by its seminal albumen being compact and shining and not pitted. The majority of its species are hardy herbaceous plants, inhabiting the cold or temperate zones of both hemispheres, growing in many instances at great altitudes above the level of the sea, all remarkable for neatness, many for brilliant floral beauty, and some for exquisite and luscious odour. Yet a considerable number, constituting a tribe, are suffrutescent plants, and natives of the tropics. The chief medical properties of the order are emetic, and seem to reside principally in the roots. About 150 species, belonging to 12 or 13 genera, occur in British collections; and about 120 of them are hardy herbs, and the rest are pretty equally divided between the greenhouse and the stove.

Between two-thirds and three-fourths of all the Violaceæ in Britain belong to the violet genus; and, excepting about 8 or 10, all these are hardy herbs,—principally perennial-rooted and annual-stemmed. The garden kinds, comprising a countless number of most brilliant hybrids and varieties, are noticed in the article Pansy. Nine of the other kinds or true species are natives of

Britain, and the rest have been collected from almost all parts and latitudes of the north temperate zone, as well as from some subtropical countries, in both the eastern and the western hemisphere. All deserve to be cultivated, either for their beauty or for their perfume. The small perennial kinds do best in pots, in a mixture of peat, loam, and sand; and the larger and hardier perennial kinds, as also the few annual kinds, do well either in rock-work or in the front of flower-borders. The American species thrive best in peat or vegetable mould, and may be propagated either from seeds or by division of the root; the greenhouse and stove species generally grow best in a mixture of loam and peat, and are propagated variously by layers, cuttings, and divisions according to their respective nature; and the hardy perennial kinds, for the most part, love a soil of peaty loam, and are most readily propagated by radical division.

The sweet-scented violet, *Viola odorata*, is an indigen of shady places in Britain. It is a low creeping evergreen, sending out runners which root at small intervals, and throwing up tufts of leaves and flowers. Its roots are fibrous; its leaves stand on slender footstalks, and are heart-shaped and crenated, and have a lively green colour on the upper surface, and a paler colour and downy appearance on the under; its floral footstalks are quadrangular, channelled, delicate, and about two inches long; and its flowers have a green five-sepalled calyx and a deep violet coloured corolla, with a large spur protruding from one of the petals, and bloom from March till May, and emit a most delightful fragrance. Seven very distinct varieties, with respectively purple, white, blue, double purple, double white, double blue, and double pale flowers, are cultivated in flower-gardens; and the normal plant is extensively cultivated, for the use of apothecaries and city herbalists, in the neighbourhood of Stratford-on-Avon and in some parts of Kent. An alkaloid, called violine, exists as a malate in the root, stem, leaves, and flowers, and has similar properties to emetine, and acts as a strong poison. The petals have a place in the Edinburgh and Dublin pharmacopœias; and were formerly regarded as anodyne and pectoral; but are now used in pharmacy only for preparing a syrup, which has gently purgative properties, and is given to infants. They have a very slightly bitter taste, and, when chewed, give a blue tinge to the saliva. The infusion of them, and also the syrup, serve in chemistry as useful and delicate tests of the presence of uncombined acids and alkalies, an acid changing their blue colour to a red, and an alkali changing it to a green.

The other indigenous species are the dog's violet, *V. canina*, a perennial-rooted, deciduous, blue-flowered creeper, about 3 inches high, inhabiting the heaths of Britain, and blooming from April till June; the three coloured violet, or fancy violet, or heart's ease, *V. tricolor*, an upright, yellow and purple-flowered annual, about 6 inches high, inhabiting the corn-fields of Britain, and blooming from April till September; the corn-field violet, *V. arvensis*, an annual, very similar to the preceding; the yellow flowered violet, or mountain yellow violet, or true wild pansy, *V. lutea*, an upright, annual-stemmed, yellow-flowered perennial, about 3 inches high, inhabiting the meadows and pastures of Britain, and blooming from May till August; the marsh violet, *V. palustris*, an upright, annual-stemmed, blue-flowered perennial, about 3 inches high, inhabiting the mossy bogs of Britain, and blooming in May and June; the hairy violet, *V. hirta*, an upright, annual-stemmed, blue-flowered perennial, about 6 inches high, inhabiting the chalky soils of England, and blooming in April and May; the milk-coloured or cream-coloured violet, *V. lactea*, an upright, annual-stemmed, crimson-flowered perennial, about 6 inches high, inhabiting the moist heaths of England, and blooming in May; and the pleasing violet, *V. amœna*, an upright, annual-stemmed, purple-flowered perennial, about 3 inches high, inhabiting the mountains of Scotland, and blooming in June and July.

Some of the most interesting of the introduced exotic species are the sweet or fragrant, *V. suavis*, a hardy, evergreen, pale blue-flowered, sweet-scented creeper, about 3 inches high, introduced from the Ukraine in 1823, and blooming in September; the palmate, *V. palmata*, a hardy, erect, annual-stemmed, purple-flowered perennial, about 6 inches high, introduced from North America in 1752, blooming in May and June, and comprising a variety with variegated white and purple flowers; the pedate, *V. pedata*, a hardy, erect, annual-stemmed, blue-flowered perennial, about 6 inches high, introduced from North America in 1759, blooming in May and June, and comprising a variety with fan leaves and light purple flowers; the winged-leaved, *V. pinnata*, a hardy, erect, annual-stemmed, violet-flowered perennial, about 6 inches high, introduced from the South of Europe in 1752, and blooming in May and June; the hooded, *V. cucullata*, a hardy, erect, annual-stemmed, blue-flowered perennial, about 3 inches high, introduced from North America in 1772, and blooming from May till July; the butterfly, *V. papilionacea*, a hardy, erect, annual-stemmed, blue-flowered perennial, about 3 inches high, introduced from North America in 1800, and blooming in May and June; the clandestine, *V. clandestina*, a hardy, erect, annual-stemmed, brown-flowered perennial, about 3 inches high, introduced from North America in 1800, and blooming in May; the Japan, *V. Japonica*, a hardy, creeping, blue-flowered, fragrant evergreen, about 6 inches high, introduced from Japan in 1818, and blooming from April till June; the mountain, *V. montana*, a hardy, erect, annual-stemmed, light blue flowered perennial, about a foot high, introduced from Switzerland in 1683,

and blooming in May and June; the peach-leaved, *V. persicifolia*, a hardy, erect, annual-stemmed, cream-flowered annual, about a foot high, introduced from Germany in 1817, and blooming in June and July; Broussonnet's, *V. Broussonetiana*, a frame, erect, annual-stemmed, blue-flowered perennial, introduced from Teneriffe in 1817, and blooming in June and July; the two-flowered, *V. biflora*, a hardy, erect, annual-stemmed, yellow-flowered perennial, about 3 inches high, introduced from Switzerland in 1752, and blooming in April and May; the spurred, *V. calcarata*, a hardy, erect, annual-stemmed, light blue-flowered perennial, about 6 inches high, introduced from Switzerland in 1752, and blooming from March till June; the arborescent, *V. arborescens*, a green-house, erect, evergreen, pale blue flowered undershrub, about 18 inches high, introduced from Spain in 1779, and blooming in April and May; the twiggy, *V. sarmentosa*, a hardy, evergreen, blue-flowered creeper, about 3 inches high, introduced from Caucasus in 1824, and blooming in June and July; Kroher's, *V. Kroheri*, a hardy, erect, annual-stemmed, pale red-flowered perennial, about 3 inches high, introduced from Siberia in 1820, and blooming in May and June; the streaked, *V. striata*, a hardy, erect, annual-stemmed, striped-flowered perennial, about 6 inches high, introduced from North America in 1772, and blooming in June and July; the Canadian, *V. Canadensis*, a hardy, erect, annual-stemmed, white-flowered perennial, about 6 inches high, introduced from North America in 1783, blooming in May and June, and comprising a variety with blue and white flowers; and the attenuated, *V. attenuata*, a hardy, erect, herbaceous, white-flowered evergreen, about 4 inches high, introduced from North America in 1812, and blooming from April till August.

VIOLET (Calathian). See Gentian.

VIOLET (Dame's). See Rocket.

VIOLET (Spurless), — botanically *Erpetion*. A small genus of low, evergreen, frame, trailing, ornamental plants, of the violet order. Two species, the ivy-leaved and the reniform, were introduced to Britain in 1823 from Australia; and both have a height of only one or two inches, and carry pale blue flowers from May till October, and love a mixed soil of sand and peat and loam, and are propagated by radical division.

VIOLET (Water). See Featherfoil.

VIPER. See Adder.

VIPER GRASS. See Scorzonera.

VIPER'S BUGLOSS. See Bugloss (Viper's).

VIRGAUREA. See Golden Rod.

VIRGILIA. A genus of ornamental exotic shrubs, of the sophora division of the leguminous order. The yellow-flowered species, *V. lutea*, is hardy, deciduous, and from 15 to 20 feet high, and blooms in June and July; and was introduced to Britain about 37 years ago from North America. Five greenhouse evergreen species, varying in height from 4 to 10 feet, and mostly carrying yellow flowers in summer or autumn, have been introduced from Africa. All the six species are propagated from cuttings; and most thrive best in a soil of peaty loam.

VIRGINIAN CRESS,—botanically *Lepidium Virginicum*. A hardy, annual, salad plant, of the pepperwort genus and cruciferous order. It was introduced to Britain from North America in 1713. Its stem is about a foot high; its leaves are like those of water cress, but somewhat more bitter; its flowers are white, and have a very short style, and naturally bloom in June and July; and its silicles have a sub-elliptic form, and are emarginate at the top. It is suitable to be used in winter and early spring salads; but is far less in request than some of the other cresses. Sowings of it should be made in light dry earth, either broadcast or in drills nine inches apart, in the latter half of August or the early part of September. The situation for it must be sheltered; and the beds of it should be covered, during severe winter weather, with light twigs, dry litter, or any similar substance.

VIRGINIAN HEMP. See Acnidus.

VIRGINIAN POKE-WEED. See Phytolacca.

VIRGIN'S BOWER. See Clematis.

VISCARIA. A genus of ornamental, herbaceous plants, of the carnation family. It was erected, not long ago, out of the lychnis genus, and may be popularly designated rock lychnis. Its name viscaria is formed from a word signifying bird-lime or glue, and alludes to the glutinousness of the stems. The neglected species, *V. neglecta*, is a hardy, white-flowered, summer-blooming evergreen of 8 or 9 inches in height; and thrives in any common soil, and is propagated by radical division.

VISCERA. The internal or contained organs of the animal body, particularly the saccous and tubular ones situated in the thoracic and abdominal cavities. The word viscus is the singular of viscera; and though most expressive when used in reference to such hollow organs as the stomach or the bowels, may also be applied to comparatively solid contained organs, such as the lungs, the heart, or the kidneys.

VISCUM. See Mistletoe.

VISCUS. Birdlime, glue, or any other sticky semi-fluid; also, a glutinous secretion or stickiness on the stems or leaves or other parts of plants; also, any intestinal organ of the animal frame. Viscera, in the last of these senses, seem to take their name from the mucous and somewhat glutinous secretion with which the intestinal organs are lubricated. See the article Viscera.

VISMEA. A genus of ornamental, tropical, evergreen shrubs, of the St. John's wort family. The Guiana wax-tree species and the Brazilian wax-tree species, both about 8 or 9 feet high, and carrying yellow flowers from July till October, were introduced to British collections in 1824; and the smooth species about 10 or 12

feet high, and carrying red flowers in July and August, was introduced about the same period; and upwards of a dozen other species are known.

VITEX. See Chaste-Tree.

VITIS. See Vine and Grape-Vine.

VITIS IDÆA. See Cowberry.

VITRIOL. See Sulphuric Acid.

VITRIOL (Blue). See Blue Vitriol.

VITRIOL (Green). See Copperas.

VITRIOL (Oil of). See Sulphuric Acid.

VITRIOL (White). See White Vitriol.

VIVES. A swelling of the parotid gland in horses. If the tumour be inflamed and painful, it must be fomented or poulticed; if it be hard and free from tenderness, it may be treated with some stimulating embrocation or blister; and if it suppurate, it must be treated in the manner of an abscess. See the article Abscess.

VOANDZEIA. A small genus of exotic plants, of the cæsalpinia division of the leguminous order. The underground species, *V. subterranea*—called by Linnæus *Glycine subterranea*, and popularly the subterranean pea—is a native of tropical Africa, and was introduced to Britain in 1823. It is a low, annual-rooted creeper; and carries yellow flowers from June till August; and is cultivated in its native country as an economical plant. It thrives best in rich mould.

VOCHYSIA. A genus of ornamental, tropical, calyciflorous, ligneous plants, constituting the natural order Vochysieæ or Vochysiaceæ. Its species are American shrubs and trees, with opposite or whorled, entire, feather-nerved leaves, binate stipules at the base of the leaves, and panicled or thyrsoid terminal racemes of yellow flowers. They are near akin in botanical character to the Combretaceæ, agreeing with them in having inverted seeds and convolute cotyledons; and they are not far from being closely allied also to the Onograriæ and the Rhizophoreæ. Fifteen are known; and one, the lofty, *V. excelsa*, an evergreen tree of commonly about 30 or 35 feet in height, loving a soil of sandy peat, and blooming in August and September, was introduced, about 24 years ago, from Trinidad to the botanical collections of Britain.

VOHIRIA. A small genus of ornamental tropical plants, of the gentian family. The roseate species, *V. rosea*, an herbaceous evergreen of 2 or 3 inches in height, carrying red flowers in July and August, was introduced about 27 years ago from Guiana to the hothouses of Britain. It loves a soil of peaty loam, and requires to be propagated from seed.

VOLKAMERIA. A genus of tender, ornamental, evergreen, ligneous plants, of the verbena family. It is nearly allied to the clerodendrums. Two species, the one a shrub, the other a tree, and both loving a soil of peaty loam and propagable from cuttings, have been introduced to British gardens from respectively India and Japan. The shrub was introduced in the former part of last century, and is described as follows by Miller:—"It sends out many weak shrubby stalks 12 or 14 feet high, covered with a white bark, and garnished with oval spear-shaped leaves, 3 inches long, and 1½ broad, of a lucid green colour and smooth; they are placed by pairs on short foot-stalks. The flowers are produced from the wings of the stalks in umbellated bunches, like the common sort of jasmine to which they have a great resemblance, but the segments of the petal are not so acute pointed; they are white, and have an agreeable odour; and they have each 4 stamina longer than the petal, terminated by single summits. The germen turns to a roundish capsule with 2 cells, each including one seed." The juice of the root and leaves has a bitter taste, and is prescribed by the Hindoo physicians, either alone or in conjunction with a little castor-oil, as an alterative in scrofula and similar affections.

VOMITING. The morbid or provoked regurgitation and rejection of food, drink, or other substances in the stomach of an animal. Regurgitation, in any form, from any cause, with or without rejection, cannot take place in monodactyles, particularly in the horse, in consequence of the peculiar organization of the stomach. See the article Stomach. Regurgitation, of a regular, functional, ruminantial kind, unaccompanied by rejection, and constituting part of an elaborate process of digestion, is natural and necessary in all oxen, sheep, and other ruminants. See the article Rumination. Regurgitation of a combinedly functional and forced kind, partly natural yet occasionally provoked, occurs in the canine and the feline tribes. "The dog," remarks Delabere Blaine, "swallows a large quantity of food at a time, and either by a partial deposit, or by delaying the process of digestion, he keeps it until he has found a hiding-place, when he regurgitates a portion or the whole. This must have been witnessed by most persons who have had bitches with their whelps in their possession. Vomition is certainly encouraged by the dog, who eats an emetic grass for the purpose; but the act is altogether a different one to that of (simple) regurgitation, as must be evident to any one who observes it. In (simple) regurgitation, the matters seem either not to have entered the stomach, and to have occupied only the cavity which exists around the œsophagus to favour its distention, or otherwise, by some capability in the stomach, it is received and retained at its very entrance, for its regurgitation is without effort, and the abdominal muscles are hardly called into action at all. Vomition, on the contrary, in him employs the abdominal muscles most forcibly; and it seems designed that he should have this means of relief at hand, seeing his stomach is placed so as to be immediately within the sphere of their action, which is so necessary to the act that, without their aid, attempts may be made, but are ineffectual, in procuring vomition." In other canine animals, and

in the feline ones, as in the dog, simple regurgitation is natural and functional, and vomiting is either morbid or provoked. But in man, as also in some other animals whose digestive system most nearly resembles his, vomiting is the only form of regurgitation, and proceeds only from disease or immediate provocation,—either mechanical tickling of the fauces or chemical action by means of some emetic on the organism of the stomach. The pharmaceutical use of provocatives to vomiting, therefore, is a nullity in the case of monodactyles, and comparatively limited in the case of canines and felines, and of full power only in the case of animals constituted like man.

VOMIT-NUT. See Nux Vomica.

W

WACHENDORFIA. A genus of ornamental, Cape-of-Good-Hope, evergreen, herbaceous plants, of the hæmodorum family. Eight or nine species, with either yellow, violet, or purple flowers, and varying in height from 12 to 25 inches, have been introduced to the greenhouses of Britain. All love a soil of rich mould, and are propagated by radical division. One of the longest known is described as follows by Miller, and may be taken as a good specimen of the whole:—"It has a thick tuberous reed-like root of a deep red colour, sending out many perpendicular fibres of the same colour, spreading into several offsets. The leaves which rise immediately from the root are large, spear-shaped, and channelled; they have 5 plaited veins, and resemble the folds in fans. The largest of these leaves are 2 feet long, 3 inches broad, and of a deep green colour. The flower-stalk rises from the centre of the heads between the leaves, to the height of 3 or 4 feet, and is garnished with leaves of the same form with those below, but are narrower, and ranged alternately, embracing the stalk half round with their base. The flowers, when young, are enclosed in sheaths, which, after some time, open and make way for the flowers to come out,—then they wither and dry, but remain upon the stalk like those of the yellow asphodel. The flowers are produced from the wings of the stalk, forming a loose spike at the top; there are several sustained upon one common foot-stalk, which open after each other, so that there is seldom more than one open at the same time upon the same foot-stalk. The upper flowers stand almost upright, but the lower nod downward; they are hairy and of a saffron colour on the outside, but smooth and yellow within, having generally 6 petals. Sometimes the lower one is wanting; but then the place is occupied by the pointal, which is a singular sport of nature. After the flower fades, the germen swells to an almost oval, three-cornered, blunt capsule, with 3 cells, each containing three purple hairy seeds, fixed to an oblong placenta."

WAGES. The price or hire paid to servants or labourers for their work. The wages of farm-servants and farm-labourers widely vary, not only according to the grade and qualifications and responsibilities of the parties themselves, but in different districts and situations, and to some extent in different seasons and circumstances. Some of the causes which enhance them are great demand for labour in neighbouring cities and manufactories, thinness of population in a rich and improving country, smart competition for workpeople among extensive farmers, dearth or scarcity of provisions, unusual severity of labour, and unusual length of time in the amount of daily work; and some of the causes which depress them are the want or decrease or cessation of manufactures, the comparative crowdedness of the rural population, the general unskilfulness or inaptitude or laziness of the peasantry, the lightness and shortness of the amount of labour, and either the cheapness of provisions or the low feeding habits of the people. A glance at these causes may explain that farm wages must be very high in the busiest districts of England and Scotland, and exceedingly low in most parts of Ireland and in the remote parts of the Scottish Highlands and Islands.

Farm-wages, in different districts and to different classes, are paid in three different ways,—first, chiefly in kind or in farm produce, and only in a small degree in cash,—second, chiefly in cash, and only in a small degree in kind,—and thirdly, altogether or almost altogether in cash. Persons paid in the first way and in the second never occur on the same farm, and rarely in the same district; but persons paid in the first and the third are often found together; and persons paid only in the third sometimes comprise the whole of the workers. Ploughmen, who constitute both the typal and the most important class of farm-labourers, are paid in all the three ways in different parts of Britain,—in the first, throughout most of the border counties of both England and Scotland,—in the second, throughout most

of the midland and northern counties of Scotland,—and in the third, throughout most of the southern counties of England. The portion of wages paid in kind, in both the first method and the second, varies in items, according to the custom of districts or to particular agreement, but generally comprises the most common and essential articles of household provision raised on the farm. See the articles FARM-SERVANTS, FARM-LABOURERS, BOTHY, PLOUGHMAN, SHEPHERD, and AGENT.

WAGGON. A large four-wheeled carriage, for the conveyance of heavy loads. Waggons are very various in size and structure, according to the different uses which they are intended to serve; and even agricultural waggons, or those which are employed solely or mainly by farmers, are exceedingly diversified, according to the mere custom of counties, or to the taste or caprice of individuals. Though tumbrils are employed in some districts for the carrying out of manure, and other light and rude carriages are employed in others for some other particular rural purposes, and one-horse carts are universally used in all the best parts of Scotland and in a small part of the north of England, and are also coming increasingly into favour in the central counties of England, for all the carrying purposes of the farm, yet waggons of some kind or other are sometimes used even in Scotland for general purposes of carriage, and are more or less in request in the great manufacturing cities for particular sorts of heavy and bulky conveyance, and enjoy general favour in some of the central and southern counties of England, and universal favour in others, for at least all the road carriage of agricultural produce. We may refer for the general principles of construction to the articles CART and WHEEL; and shall here make only brief notice of the peculiarities of some of the best or most favourite or otherwise most remarkable varieties.

The Sussex waggon stands 6 feet high at the back and $5\frac{1}{2}$ feet at the front, and measures nearly 14 feet in length of lade. Its bed or floor, in very many instances, is narrowed behind the fore-wheels, so as to allow the wheels to lock round in the shortest possible curve, and to give the waggon great convenience and ease in turning; but this peculiarity both diminishes the capacity of the waggon, and somewhat weakens its body; and therefore, in other instances, the bed is made straight; and contrivances are adopted to prevent the wheels from catching on the lock. The tail-board falls down for the convenience of loading, and admits of being so adjusted as to extend the length of the body; and the waggon can easily be converted, by means of hind and fore ladders, into a capacious wain for the in-carrying of hay and corn from the harvest field.

The Hampshire waggon is not very much different from the Sussex one, and contains, without heaping, about 66 bushels, and is generally compact, firm, and strong, with close-boarded or open raves; but is usually straight in the floor, and is seldom furnished with either hind or fore ladders, and is therefore less convenient and has a smaller range of adaptation than the Sussex waggon.

The Woodstock or Oxfordshire waggon has a convex curvature of the rails over the hind wheels, and has both a symmetrical appearance and a very convenient structure. The length of its top-rails is 12 feet 4 inches; the breadth of the top-rails, 1 foot; the length of the fore part of the bed, $5\frac{1}{4}$ feet; the length of the hinder part of the bed, $5\frac{3}{4}$ feet; the width of the fore part of the bed, 3 feet 8 inches; the width of the hind ladder, 4 feet 4 inches; the breadth of the contraction in the bed to allow of the locking of the wheels, 11 inches; the width of the tail-piece, 6 feet; the width of the fore-ladder, $4\frac{1}{4}$ feet; and the distance between the wheels on the ground, $5\frac{1}{4}$ feet.

The Berkshire waggon has a general resemblance to the Woodstock one, but is lower, and has shallower sides and a smaller capacity. It is well constructed and of convenient size and good appearance; and though smaller and simpler than most other varieties of English agricultural waggons, it might serve as a model for them all, and, when furnished with fore and hind ladders, carries a large load of hay or straw or unthrashed corn.

The Norfolk and Suffolk waggon is very heavily built, and possesses a cumbrous character utterly out of keeping with the flat surface and fine roads of most of the districts in which it is used; and, though a horse's draught heavier than the Berkshire waggon, it does not carry so great a load. It is 12 feet long, 4 broad, and 2 deep, and it commonly carries 10 quarters of wheat, and requires to be drawn by four horses on turnpike-roads, and by five on bye-roads. Its chief recommendation is that it locks so far under the bed as to admit of being turned round as curtly as a post-chaise.

Torr's two-horse spring waggon, invented by W. Torr, Esq. of Riby, near Grimsby, and made by Mr Crosskill at the Beverley Iron-Works, is constructed with a light broad body and solid rung sides, and carries $2\frac{1}{2}$ tons of corn in bags, and loads well with hay or corn. It is mounted on springs, and with Crosskill's patent wheels, patent iron axles and oil-boxes. The manufacturer says, "It is well adapted for speed, to trot to market with ease, at the rate of 4 or 5 miles per hour; it is intended for carrying out the system of generally working horses in pairs only, together with the various implements of the farm, as the plough, harrow, drill, &c.; and in harvest-work, it will successfully compete with one-horse carts, particularly where the distance is great." It obtained a prize at the Gainsborough meeting of the North Lincolnshire Agricultural Society in 1845.

The equirotal farm waggon, invented and manufactured by Mr. Stratton of Bristol, is constructed with a cross-lock and with four large wheels of equal diameter, and has a remarkable facility of turning in very small space. "In this waggon," says Mr. Stratton, "two horses, of average size and strength, have drawn with ease 3 tons, on ordinary roads. In addition to the advantages of equirotal wheels and the cross-lock, attention is requested to the nearness of the top of the body to the ground, by which a great lessening of the labour of loading and unloading is effected,—to the great length and breadth of the body, by which the load may be kept low, a great object in hilly districts,—and to the patent self-acting drag (the invention of Mr. Thatcher), which will be found to increase its utility. It is fitted with long portable hay ladders, before and behind, the addition of which enables it, in a hilly country especially, to carry larger loads, and with much greater safety than can be carried by an equal number of horses in carts. It is submitted for competition, as the best agricultural carriage for the general purposes of road and field." This waggon was highly approved by the judges of implements at the meetings of the Royal Agricultural Society in Bristol and Derby.

The equirotal spring waggon, also invented and manufactured by Mr. Stratton, is simply a modification of the equirotal farm-waggon, and differs from one which obtained a prize at Derby only in having the body lower so as to increase the facility of loading. "It possesses most of the advantages of the equirotal farm waggon," says Mr. Stratton, "with the addition of springs; and it is fitted with a pole for two horses to work abreast, and a portable driving-seat and footboard, and patent axles, and is recommended as being peculiarly adapted for a road-waggon, for the delivery of produce, as much time may be saved by going, when loaded, at a quicker pace than can be adopted without springs, &c."

The narrow-wheeled hoop waggon, generally used in Wiltshire, Gloucestershire, and Somersetshire, admits the use of such a high hind wheel as, when the load is proportioned to the diameter of the wheels, to obviate in some degree the disadvantages of low fore wheels. A superior variety of this waggon, manufactured by Mr. Stratton, is figured in *Plate LXI.*

The tipping waggon has 3½ inch wheels, and is constructed with double shafts to go inside when required; and besides being well adapted for the general purposes of the farm, is particularly useful in the carrying of large quantities of lime, sand, clay, coal, or similar loads, for short distances, since it occasions a saving of time and labour in unloading.

The hermaphrodite waggon is a temporary but very useful carriage, employed in Norfolk and other districts, and formed by bolting two carts together. The thill of the hind cart passes under the bed and rests on the pillars of the fore one; and the two are jointly as compact and manageable as if they really formed a single carriage. A very good harvest hermaphrodite waggon is sometimes formed by bolting a cart upon a pair of old waggon shafts and fore-wheels, the shafts of the cart resting on the bolster of the waggon-wheels, and a very long fore-ladder resting above them and upon the bolster, and projecting over the shaft-horse.—A peculiar kind of waggon used for particular purposes in some woodland districts, is noticed in the article Bavin Tug.

A controversy of similar keenness and obstinacy to that about the comparative merits of wheel-ploughs and swing-ploughs has long raged among both literate and illiterate farmers respecting the comparative advantages of waggons and one-horse carts; and, as in the case of the ploughs, it is in a good degree a sort of national dispute between the English and the Scotch, and seems, in general, to be practically determined vastly more by prejudice and custom than by argument and common sense, and, when coolly examined, may be seen to contain a large measure, and perhaps not far from an equal measure, of truth and error on both sides. The merits of it, together with good conclusions for the guidance of inexperienced farmers respecting it, are well stated as follows by Mr. Youatt:—"The advocates of light two-wheeled carts assert that a horse working alone is capable of performing more work than when forming one of a team; and that in consequence of this increased effect, there is a saving of expense nearly in the proportion of three to two, or one-third. The advocates for waggons assert, on the contrary, that it requires that each horse in a single-horse cart should be of a superior quality, and therefore more expensive than those of a team, where the average power only is considered; that the wear-and-tear, first cost, and expense of attendance of several small carts, is greater than that of a waggon carrying the same load; and that in consequence there is an economy obtained by the latter. Numbers of facts and the results of long experience are adduced on either side, all of which convey much useful information; and the substance of the whole appears to be, that with light single-horse two-wheeled carts, good horses are able to draw greater loads, and do more work in proportion than a waggon team; that these carts are easier loaded and unloaded, do less injury to the roads, and that they do not require more horses in action than are sufficient for the work to be performed. On the other hand, it is found that the horses must be stronger and better fed; that being entirely dependent on their own exertions, and doing more work, they are more fatigued and sooner knocked up; that on rough roads they are liable to be shaken and injured by the sudden movements and shocks of the cart, all of which are conveyed by the shafts directly to the

horse; that in ascending or descending hills, the whole weight being above the axle-tree, it destroys the balance, and is thrown too much upon the horse in the former case, or tends to raise him from the ground in the latter, which even if any alteration of the balance be found advantageous, is exactly the contrary of what would be necessary. That with a waggon—the average power of several horses is obtained—horses of inferior quality may therefore be used;—they are not so much fatigued, because by relieving each other they can alternately exert themselves or relax. Greater loads can be carried with less attendance of drivers, and they are less liable to accidents; they are easier withdrawn from any hole, or forced over any obstruction, because only half the load being upon each pair of wheels, the whole force of the team is applied successively to each half of the load, consequently in any bad road the power occasionally required is less, although the draught of the carriage, properly speaking, is greater than that of a two-wheeled cart. These various arguments would appear to lead to the conclusion, that upon good roads, and for short distances, with good horses, two-wheeled single-horse carts are the best; but that, with inferior roads and ordinary horses, light four-wheeled waggons, with a team of three or four horses, are the most advantageous. Two-wheeled carts with two horses are decidedly inferior to either of these: the shaft horse suffers all the inconveniences complained of in the single-horse cart, and the leader does not produce more effect than when in a waggon team. It is impossible to decide generally upon the comparative merits of the different arrangements, because the result depends entirely upon the circumstances of the case. We may, however, endeavour to unite in some degree the advantages claimed by both. The draught of a cart is less than that of a waggon for several reasons,—amongst others, because the wheels are larger and the horse produces more effect, because his force is applied immediately to the resistance. A light waggon with large front wheels would not be much inferior in point of draught to the cart, and two horses abreast in double shafts would work with equal advantage to the single horse; while an additional horse may always be applied when an excessive load or the state of the roads should require it."

WAGTAIL,—scientifically *Motacilla*. A genus of passerinous birds, of the warbler family. Their bill is more slender than even that of the fauvettes; their legs are long; their scapular feathers are extended enough to cover the top of the folded wing, and give them an affinity to the majority of the waders; and their tail is long, and is continually in upward and downward action or "wagging."

The pied wagtail or Yarrell's wagtail, *Motacilla Yarrelli*, is a British bird, and has generally been confounded with the white wagtail of Continental Europe, *M. alba*, or with the ashy wagtail of the Linnæan or old zoological nomenclature, *M. cinerea*, but possesses some quite distinct and peculiar though not very marked characteristics. It abounds in most parts of Britain, and resides throughout the year in the southern parts of England; and it is everywhere known, to even careless observers, by its pied black and white plumage, and its remarkable nimbleness and airiness and constancy of action. It lives on aquatic insects; and frequents moist pastures, the wet parts of pleasure-grounds, and the vicinity of pools and streams; and may often be seen wading in shallow water, in search of its prey. It has a very elegant form and a very graceful activity; and it is ever in motion, skipping from spot to spot, flitting and curving in short flights, chirpingly leaping on the wing, buoyantly alighting on the ground, and constantly wagging its tail with a graceful fanning motion. The male is 6½ inches long; and the female is 6. The nest is built sometimes on the ground, sometimes in a hole of a wall, and sometimes in the side of a hay rick or turf wall or peat stack, but always in the vicinity of water; and it consists of moss, dead grass, and root fibres, lined with hair and a few feathers. The eggs amount to 4 or 5, and have a white ground colour, speckled with ash, and measure 9 lines in length and 7 in width.

The grey wagtail, *Motacilla boarula*, is much less abundant in Britain than the preceding species, and generally migrates in spring from the southern countries to the northern, and in autumn from the northern to the southern. It frequents marshes and water-meadows, and is seldom seen on such comparatively dry grass lands as are partially frequented by the pied wagtail. It has a total length of 7¾ inches, nearly one half of which consists merely of the tail-feathers. The nest is built on the ground, usually in the near vicinity of the waters where the bird obtains its prey, and generally on some tufty bank or rugged surface whose inequalities afford ready concealment. The eggs amount to 5 or 6, and have a yellowish-white ground-colour, mottled with a various tint of pale brown, and measure 8½ lines in length, and 7 in width.

The common yellow wagtail, or Ray's wagtail, *Motacilla Rayi*, abounds in Britain throughout the summer, but leaves our southern shores in September, and arrives again in April. It frequents downs, pastures, fallow-lands, fields of young green corn, fields of pease and vetches, and other kinds of cultivated ground; and may generally be seen to the greatest advantage, perched on a clod or stone in a quite bare field. Its breast has a rich yellow colour, and its tail is in constant fanning motion. Its total length is 6½ inches. The nest is built on the ground, and usually consists of dried bent and root fibres, lined with hair. The eggs amount to from 4 to 6, and have a whitish ground colour, mottled

nearly all over with yellow brown and ash brown, and measure 8½ lines in length and 6½ in width.

WAHLENBERGIA. A genus of ornamental, exotic, herbaceous plants, of the bellflower family. Two annual species, one erect perennial-rooted species, and one creeping evergreen species, all hardy and blooming in the latter part of summer and early part of autumn, have been introduced to Britain; and they have either blue or whitish flowers, and are nearly allied to the true campanulas, and will generally thrive in any common garden soil.

WAIF. A strayed animal or drifted piece of goods which, for want of the owner's appearance after it has been cried and published in the neighbouring markets, is forfeited to the lord of the manor. The law of waifs, however, belonged properly to the old feudal system.

WAIN. A large, rude, or ox-drawn variety of agricultural waggon. The wain of some districts is simply any large vehicle drawn by oxen; that of others differs from a waggon principally in wanting side-rails or ladders; and that of others differs from any coarse kind of waggon in little else than the name. See the article WAGGON.

WAKE-ROBIN. See ARUM.

WALDSTEINIA. A handsome, hardy, yellow-flowered, perennial-rooted, annual-stemmed plant of the rosaceous family. It has a height of about 6 inches, and blooms in June and July, and thrives best in a soil of loamy peat. It is a native of Hungary, and was introduced to Britain about 45 years ago; and it constitutes a genus of itself, and is specifically called *geoides* or avens-like.

WALK. An artificial footpath through a garden, pleasure-ground, or park. See the article LANDSCAPE-GARDENING. A walk may be either straight, curved, or serpentine; and may be formed either of grass, or of gravel, sand, powdered brick, powdered coal, or any similar material.

Grass walks were formerly held in great esteem, and, during the prevalence of the Dutch taste, were regarded as necessary ornaments to gardens; but they eventually became unfashionable, and have long been voted untidy, disagreeable, and vulgar. "These long narrow slips of grass," it is said, "are far from being pleasing to the eye, and are for the greatest part of the year useless, being generally too damp for persons of tender constitutions to walk on; and wherever they are constantly used, they become bare in the places frequently trodden, and so are rendered more unsightly. And as the intention of walks in gardens is to have at all seasons a dry communication through them for exercise and recreation, grass walks are very improper, because every shower of rain makes them so wet as not to be fit for use for a considerable time, and the dews render them too damp to walk on either in the morning or evening; and if they are not kept constantly close mowed, they become not only unhealthful but troublesome to the feet. Besides, whenever the ground is so dry that persons may with safety walk upon grass, the lawns and other parts of verdure in gardens are most suitable for the purpose." Yet, in some situations, particularly behind lengthened screens of trees, or in some portions of gardens which do not contain any lawn, grass walks form an agreeable variety and are highly desirable. The space intended for them should be digged and levelled; the surface soil itself should be good, yet a thin layer of sand or of poor earth should be spread immediately below it, to prevent excessive luxuriance; and the grasses sown should not comprise any annual, coarse, or wiry species, and may consist of *Poa trivialis*, *Festuca ovina*, *Festuca duriuscula*, *Cynosurus cristatus*,—and, in shady situations, of *Poa nemoralis*.

Gravel is the best material for a firm or earthy walk; but is exceedingly various in quality, and may make either a prime walk or a very bad one according to its kind. Very good gravel is sometimes found on the sea-shore; but the better sorts are generally obtained from inland pits; and the most celebrated in Britain occurs at Kensington and Blackheath, and is conveyed thence in considerable quantity to remote parts of the kingdom. The space for a gravel walk—as also for one of any similar material—should be excavated to the depth of about 20 inches; and the lower half of its depth should be filled with rock rubbish, flint-stones, small boulders, or any similar substance, to prevent worm-casts and the growth of weeds, and the other half filled with successive assortments of the gravel, or with a mixture of it and loam, according to the degrees of its coarseness and cohesiveness. The common superficial convexity allowed for a gravel walk of five feet in breadth is an inch in the crown; so that if a walk or drive be twenty feet wide, it should be four inches higher in the middle than at the sides. When a gravel walk has been evenly laid, trodden down, and raked, it should be rolled well both in length and in width; and in order that it may be sufficiently firm, it should receive three or four water rollings, or rollings immediately after a heavy fall of rain, so that the gravel may bind, and become as hard as stone pavement. In summer, the walk must, from time to time, be hand-hoed and raked, to clear it from weeds and tufts of grass; and after every such operation, or even sometimes after a simple sweeping, it should be rolled with a hand roller.

Sand walks are less expensive to make and keep than gravel ones; and sand walks which go through woods and plantations are much drier and wholesomer than gravel ones; and whenever they appear mossy or weedy, if they are scuffled over with a Dutch hoe in dry weather, and raked smooth, they will appear as fresh and handsome as when first laid. The breadth of such walks and drives should be proportioned to the size of the ground; and in a large extent

may be twelve or fourteen feet wide, but in small gardens five or six. The ground for them being traced, the earth should be taken out, and laid in the quarters. The depth must be proportioned to the nature of the soil; for where the ground is dry, the walks need not be elevated above the quarters, and the earth may be taken out to the depth of four or five inches; but where the ground is wet, only two inches may be taken out, and the surface should be raised so high as to throw off the wet into the quarters. After the earth is taken out, the bottom should be laid with rock rubbish, coarse gravel or any similar material, to the thickness of five or six inches, and beaten down close; and then a layer of sand about 3 inches thick should be laid on, trodden down, raked over, and made thoroughly level and smooth. The sand should be such as will bind well and at the same time have no tendency to become mortary; for if it be too incohesive and loose, it will slide from under the feet in dry weather, and may even be drifted by strong gales of wind; and if it be too much of a loamy nature, it will stick to the feet in wet weather, and become poached and corrugated.

WALK. The slowest natural pace of a biped or a quadruped. In the first action of the walk of the horse, one of the hind legs is lifted and carried forward, both of the fore legs become inclined backward, and the diagonal fore leg is lifted and carried forward; and in the second action, the other hind leg is lifted and carried forward, both of the fore-legs again become inclined backward, and the opposite fore leg is lifted and carried forward. But the pace, though thus simple in its easiest and slowest mode, is completely altered by acceleration of speed, and may be performed laterally as well as diagonally, and may become ready to glide into either the trot or the amble according to the mode of its movement and the degree of its speed.

WALKERIA. A small genus of ornamental, tropical, evergreen, yellow-flowered, ligneous plants, of the ochna family. Two species, the serrated and the entire-leaved, have been introduced to British hothouses from respectively India and Guiana; and both have a height of about 12 or 14 feet, and love a soil of peaty loam, and are propagable from cuttings. The roots and leaves of the serrated species have a bitter taste; and a decoction of them, either in water or in milk, is used in India as a tonic, a stomachic, and an antiemetic.

WALL. The elementary structure of masonry,—whether of stone, or brick, or of other material; and it either may exist in its simple elementary character, as when it forms a plain fence, or may be combined with all the other structures of masonry, and with many of those of ornamental architecture, as when it constitutes the main fabric of houses, from the smallest and humblest to the largest and most ornate. The chief kinds and properties of it, when built of stone, are discussed in the article Masonry; the principal constructions of it, when built of brick, are discussed in the article Brickwork; the main forms and adaptations of it for the purposes of the farmery, are noticed in the article Farm-Buildings; and the most important kinds and varieties of it suitable for horticulture, are noticed in the article Garden. All that remains to be done in this place is to discuss the important practical subject of dry stone walls as a fence for fields; and this we shall do by giving an abridgment of a long and valuable paper by Mr. Stephens in the third volume of the Quarterly Journal of Agriculture.

Should materials appropriate to the purpose of building stone-walls be plentiful at a short distance—should the situation be so elevated, or exposed to such a cutting wind, as to produce baneful effects on the growth of hedges—should much of the time in summer not be always required to prosecute what may be called the extraordinary operations in summer fallowing, such as draining, carting lime and manure from a distance—by all which favourable circumstances the expense of constructing stone-walls will be much decreased—stone-walls may be preferred to hedges as a fence. There are some situations, too, in the most favoured soils for the growth of hedges, in which walls may be introduced with advantage; as in those parts of low lying fields near the margins of sluggish rivers, which are liable to inundate their banks in winter, or even during the periodical rains in summer. Hedges in such situations lose their vigour of growth, and become a prey to parasitical mosses and lichens. In hollow grounds near bogs or fresh-water lakes, over which vapours are frequently suspended during the nights in summer, and which blight the vegetation of the most vigorous hedges, stone-walls are preferable to hedges. The sides of paths leading to watering places from fields, and particularly if they are environed with plantations, are best protected by stone-walls. Around plantations on sandy or gravelly soils, where no ditch is required to carry off surface-water, or on a bleak moor, where the soil may be too scanty and poor for the successful growth of a hedge, a stone-wall may be found the most efficient fence.

Most of the stone obtained from quarries of amorphous rock, however durable it may be in its texture, forms inconvenient materials for dry built walls. Basalt, and some of the older sandstones, together with most of the rocks of the older formations, may be classed under this character. Greenstone, clinkstone, and the newest sandstones, often exhibit even cleavages which qualify them as useful materials for dry-stone walls. And yet, either from the want of care, or knowledge in the proper dressing of these latter stones by the hammer, they frequently form uncouth-looking fences. From their rugged appearance, they indeed form formidable barriers

against the attempts of cattle; but they present a very unworkman-like aspect, not unlike the rude attempts of primeval cultivation. Rolled masses of rock, of the older formations, make the very worst materials for stone-fences. Round stones present so small and smooth a surface while in contact with each other, that they cannot long retain the position in which they have been placed, without the aid of mortar. On this account also, they are unfit to be used as a coping to any wall. Their excessive hardness repels the free use of the hammer. They may be used, however, with advantage as foundation stones; and as many such masses are found near the surface of the ground, in the act of clearing away the obstructions to its cultivation, they can be got rid of in the most economical manner, by being thus usefully employed. Sandstone of a slaty structure, and slate-clay, are desirable materials for walls. The former sometimes, however, presents a smooth hard surface when split into thin layers, which property permits the sliding of one stone over another, when built in a wall, and which endangers its stability; while the latter, having an excess of alumina in its composition, which being frequently decomposed by the action of the atmospheric air, crumbles into powder. Both of these evils must be avoided as much as possible, by rejecting the improper materials which produce them. The very best material for the construction of dry-built walls as a field-fence, is supplied by those rolled masses of sandstone found in gravelly deposits. They occur in size from 1 foot to 4 feet in diameter. Containing small plates of mica in their composition, they easily split into thin layers immediately after they are extracted from the gravel in their naturally damp state. These layers harden by exposure to the atmosphere. Very often they exhibit a smooth and straight fracture across their face, and this property causes them to be easily divided into conveniently sized stones for building, which is often accomplished by merely throwing them upon each other into a heap. These layers split with parallel faces, and they have a rough granulated surface, which makes them readily adhere to one another by friction when they are built into a wall. Such material leaves no waste, and, when properly built, forms a more compact, stronger dry wall than any other kind of stone.

Much of the stability of any wall, of whatever material it may be built, will depend on the knowledge and dexterity of the builder. The best builder of a dry wall is he who practises no other kind of building than of dry materials; for any ordinary mason, particularly in building rubble-work, depends so much on the lime keeping the smaller stones safe in the inside of the wall, that he will not take the trouble to embed them firmly. The implements to be used are a wooden frame, of the shape and size of a vertical section of the wall to be erected,—a common mason's hammer, about four pounds in weight,—a line, and a pick and shovel to prepare the ground for laying the foundation. The wooden frame should be 2 feet in breadth at the bottom over the wood, 15 inches wide at the upper edge of the cross rail near the top, which latter point should be 3 feet from the bottom, and the whole height of the frame may be 3 feet 3 inches.

In choosing a line of fence for the foundation of a wall, the ground should be as hard as possible, to prevent it from sinking. A good foundation may be found either upon a natural sward, or upon removing the soil which had been disturbed by the plough. If the soil is deep in any part of the line, the arable or soft part alone may be thrown aside; or, if it is not very soft, the largest and flattest stones may be used as a foundation upon the surface of the ground. The arable soil which is thrown out of any foundation may be used as a compost or top-dressing. All sudden turns or curves in such particular line of wall should be avoided, as well as any sudden elevation or depression in a vertical direction, as these points will be found to be the weakest in a wall. The curves should be made segments of as large circles as the circumstances of the case will admit; and sharp elevations of ground should be cut down to a moderate curve, even though this work, for the sake of the wall, should cause additional trouble in removing a little of the circumjacent earth. Over a slight depression of the ground, if of considerable extent, the top of the wall should run along a line of the same apparent elevation, for the sake of its general uniform appearance.

The stones for building should be laid down immediately after the line of fence is fixed upon. If the ground is clear on both sides of the line, double horse cart-loads of stones should be laid down within two yards of each other fron centre to centre of the load, on each side of the line. If one side only of the line can be approached by the cart, they must be placed within one yard from centre to centre of the heap, that is, as close to each other as they can be emptied out of the cart. For the convenience of the builder, the large boulder-stones meant for forming the foundation of the wall, should be laid down at first on the ground previously prepared for the foundation, and the common building stones should be afterwards placed as near to the hand of the builder as is practicable, without intruding too much on the space allotted to the foundation.

Poles and stakes should be driven along the whole line in the centre of the space to be occupied by the wall, in order that it may be continued straight. The frame is then to be placed in advance on the line to be built on. It must be set in a perpendicular position by a plumb line, hanging down in a line which bisects the frame in a vertical direction, and it is kept steady in its position by a stick, having a notch cut into one end of it, or a nail driven into it, and which

notch or nail rests on the upper rail of the frame, and the other end of the stick rests upon the ground, and is there made firm by the weight of a large stone. Another frame, or small stakes, may be temporarily erected at the point which forms the commencement of the wall, till the first length of it is finished, after which the wall itself will serve the purpose of the temporary frame. A building line is then stretched on the outsides of the frame, on each side of the wall. Two builders, one on each side of the wall, will perform the work much better than one can do by himself. One man cannot carry up both faces of the wall simultaneously. He must first do the one and then the other, which prevents him building so firmly as when both are built up together. If boulder-stones are used for the foundation, they must be placed firmly on their base on the ground, by wedging them with the hardest stones. They must not yield in the least to the tramp of the feet upon them. They should be placed at a little distance from one another, one in the alternate face of the wall, in order that a firm piece of building may be erected between them. If they have a square face, the appearance of the wall is improved by presenting it to the outside, though the mere appearance of the wall is of less importance than the placing of a flat surface upwards for the support of the superincumbent building. It is highly commendable to cause these large stones, or indeed any form of stone in the foundation, to project three inches at least beyond each face, so that the wall will stand upon a base of two and one-half feet in breadth. Thus placed, these base stones are said to form a "toe" to the wall, which certainly imparts a very firm footing to it.

Most sandstones, even of the hardest kinds, absorb water very readily, and, if saturated by rain before frosty weather, the frost takes effect on them, and often splits and injures many of them. But if they are placed in an inclined position on each side of the wall, the rain will not be able to find access into its interior, and must drip down its face to the ground. This inclination should be downwards towards the outside of the wall, and it is formed by laying the exterior edge of the stone upon the same edge of the one immediately below it, and elevating its interior edge a little, and keeping it in that position with a flat stone placed under it as a wedge. After the spaces between large stones, when they are used, are built up, and brought nearly to a level, or, after the wall is built about half-way up with ordinary stones, when they alone are used, it is desirable, if the nature of the materials used admit of it, to lay large flat stones across the whole breadth of the wall, or nearly so, as binders to the building below, and upon which the upper part of the wall may be more securely placed. These stones are called 'thorough bands.' These bands are very serviceable to the wall in cases of violent concussions against it, which might drive off the coping, and the upper part of the building, but which in such cases might not affect it to the foundation. The wall is then built up, with the stones in the above inclined position, upon the band to the height of three feet, which is the ordinary height of the building for a common stone fence. Some thin stones will be necessary to be laid on the top, to make the building level for the reception of the cover, which should now be placed not only over the whole breadth of the wall, but projecting about two inches on each side of it. This cover should be made of stones selected from the rest for their flatness, strength, and apparent durability. It is not necessary that all the covers should be of the same thickness, for the coping can be formed of lower stones over the thickest covers. These covering stones secure effectually the top of the wall, and prevent much of the rain that, without them, would descend into the inside of the wall. Even if the coping should be thrown off at any time, the wall itself will be preserved if the covers remain unhurt.

The coping may be formed of all those stones which had been rejected in the building, provided they are not too small. Mere waste shivers are unfit for any part of a wall, but they may be used in draining. Strong angular stones which can stand close and firm together, form good coping. Round stones are very objectionable, as they are ever rolling off, and the small stones which it is necessary to use as wedges in keeping them steady, are easily displaced. The best coping is made of flat stones placed on edge. The edge on which they stand on the cover should not be of a round form, as with that form they will easily lose their balance. It should rather be curved upwards like an arch, so as the cope may stand on two extreme points only. It is advisable to place the broadest cope-stones over the joints of the covers, in order to obstruct the passage of the rain through them into the heart of the wall. After a number of cope-stones are placed firmly together, and perpendicularly beside each other, thin hard stones should be driven in the openest spaces between them as wedges, so as to render the whole coping one connected row of stone.

The finished wall presents a breadth in end of $2\frac{1}{2}$ feet at the base, and 15 inches immediately below the cover. The cover may be from 2 to 3 inches in thickness. The cope will stand nearly a foot in height, so that the height of the whole wall will not exceed 4 feet 3 inches. Such a wall is called a five quarter one,—its body measuring 36 inches, which are four quarters of a yard of 9 inches each; and the cover and cope, which stand 1 foot 3 inches, are considered equal in labour to the building of another quarter of 9 inches. This is the ordinary height of dry stone field fences, and it will be found to form an efficient fence for the confinement of the ordinary kinds of live stock.

A most important consideration respecting dry-stone wall fences is to render them efficient for confining mountain sheep. It is found that a five quarter wall cannot confine that kind of sheep; nor, indeed, can a much higher wall do it; for they have a clambering way of scaling, not leaping, high walls. The propensity in these creatures to leap fences, is strongest, when they are brought down at first to the low country from the hills. After they have acquired some condition by feeding, the desire to escape, in a great degree, leaves them. There is a device, however, which has been practised with some success on these walls, to keep them in at first, and that is, to erect long stones, like pavement stones, about a foot above the ordinary coping, at short distances from one another, among the coping-stones. These stones have a notch cut into their upper edge, which can support a small rail of wood, or a rope of twisted straw. This rail or rope appearing to them so frail, as not to be able to bear their weight at such a height, seems to deter them from attempting to leap the wall. Sometimes small branches of furze are stuck in between the cope-stones as objects of terror to them, but which are objectionable, in as far as when they begin to shrink in withering, they lose hold of the wall, and are blown about among the sheep by the wind; and, as they generally get entangled among their wool, they become sources of serious annoyance to the sheep, particularly in spring, as they feed on turnips, when the weather is often windy, and the ground bare.

In a line of wall, near perhaps the outside of the farm, through which there is no traffic by carts, but which may be adjacent to a common or moor, over which the sheep may sometimes be allowed to ramble, an opening in the wall will serve the purpose of egress and ingress to the sheep, better than a common gateway. Such an opening will be found a convenient outlet in any part of the farm, for the sheep at particular seasons, such as lambing-time, for the ewes and lambs to pass through a short cut to the new grass, or for sheep feeding on turnips, to pasture on an adjoining part of the lea in wet weather. This opening should never be made less in size than will easily admit a free passage to a ewe big with lamb.

It is the practice of some fence-builders to allow the thorough-band to project beyond one or both faces of the wall, to show that it is a thorough-band stone; and they even leave others projecting out of the wall, on the pretence that they would rather do that than run the risk of breaking a good stone to pieces. A dexterous hand at the hammer will never break a good stone uselessly. These projecting stones are not only temptations to wandering people, who are constantly trespassing through the country, to step over walls, to the danger of pushing off their tops at least; but the end of the horse-trees catches hold of them when the plough passes as near to the wall in ploughing as it can go. If the builder should leave a small or thin edge of a stone projecting beyond the wall in building, or the edge of a cover too far out, he should break the projecting part off by a smart blow with the hammer when the building is finished, and the pressure of the superincumbent building will greatly assist in breaking it off at the point of projection.

When a wall has two faces, it is said to be a double one; and in all cases where two fields are separated by a wall, it should be a double one. But should the wall be between a wood and a field, then the side next the wood need not be finished so finely as the one next the field, as it will not be so much seen, though it will be as strong as the other; and, therefore, in choosing from a great mass of materials, some of the coarser should be taken to the side of the fence next the wood. Any projecting pieces left next the wood will do no harm. Sunk fences should be built with a taper back towards the top, and the space between the earth and the wall should be well packed with stones for the sake of stability. Inattention to this packing sometimes causes a dry-built earth-fence to fall down by the pressure occasioned behind the wall by the swelling of the earth.

Where a wall has to cross an old-est blished footpath, it is expedient for the safety of the fence to construct easy steps in the wall at that part of it, for the sake of allowing the passengers to step over with facility; as, in every such case, the more easily the passage can be effected, the less damage will accrue to the wall. These steps can be made either of stones, or of wood built into the wall itself; or a wooden stair placed astride over the cover of the wall will serve the same purpose. They are much better than those cross turn-stiles which are sometimes used, and which cannot keep in sheep. Small ladders of the former kind are useful in saving the fences from the passage of shepherds, who may have frequent occasion to walk to the extremities of the farm, even late at night, to look after the sheep, and who cannot be expected to go always round by the gateways.

WALL-CRESS,—botanically *Arabis*. A somewhat large and diversified genus of herbaceous plants, of the cruciferous order. Six species grow wild in the British Islands; about fifty have been introduced from other countries, principally Continental Europe, North America, and North-eastern Asia; and nearly twenty more are known. A few of those in Britain are annuals, more are biennials, and the majority are evergreen perennials; some are creeping, and most are erect; about one half have a height of from 3 to 9 inches, and the rest vary in height from 9 to 30 inches; many have clasping cauline leaves, and many sessile cauline leaves; some have either sulphur-coloured, pinkish, reddish, bluish, or

purplish flowers, and almost all the rest have white flowers; about one-third have marginate seeds, and most of the others have immarginate seeds; about one-fourth or so are more or less ornamental, and all the rest are uninteresting and weedy; all are hardy, and most thrive well on rock-work, old walls, or any common soil. The indigenous species are the hairy, *A. hirsuta*, an erect weedy perennial of about a foot in height, inhabiting the rocks of both England and Scotland, and carrying white flowers from May till July; the upright, *A. erecta*, an erect handsome perennial, of about 6 inches in height, inhabiting the rocks of some parts of England, and carrying cream-coloured flowers in May; the tower mustard, *A. turrita*, an erect weedy biennial, of about 20 inches in height, inhabiting walls in some parts of England, and carrying sulphur-coloured flowers in April and May; the common or Thalius's, *A. thaliana*, a weedy annual, of about a foot in height, inhabiting walls in both England and Scotland, and carrying white flowers in April and May; the ciliated, *A. ciliata*, a handsome biennial of about 6 inches in height, inhabiting the shores of some parts of Ireland, and carrying white flowers in June and July; and the rock, *A. petræa*, a creeping ornamental perennial, of about 6 inches in height, inhabiting the rocks of Scotland, though introduced of a more normal form from Austria, carrying white flowers in May and July, and comprising a hastulate-leaved, purple-flowered variety, which inhabits rocks in both England and Scotland.

WALL-EYE. A horse's eye, with a whitish or light-coloured iris. A wall-eyed horse is generally good.

WALLFLOWER,—botanically *Cheiranthus*. A genus of ornamental, fragrant, evergreen plants, of the cruciferous order. One species grows wild in Britain; about a dozen species, besides many varieties, have been introduced from other countries, principally Southern Europe and Northern Africa; and six or seven other species are known. One of the species in Britain, *C. ochroleucus*, is a hardy, evergreen herb; and all the other species are greenhouse or frame or slightly tender evergreen undershrubs, varying in height from 6 to 40 inches; and about one half have scarcely any styles and immarginate seeds, while the rest have filiform styles, marginate seeds, and four-sided silicles.

The indigenous or small shrubby wallflower, *Cheiranthus fruticulosus*, inhabits old walls in various parts of Britain, and is also admitted to a place in flower-gardens. Its stem is erect, shrubby, determinately branched, and from 6 to 20 inches high; its branches are angular, leafy, and beset with close, bristly, silvery hairs; its leaves are stalked, crowded, lanceolate, acute, and of a deep green colour; and its flowers are corymbose, fragrant, and of a bright yellow colour, and bloom from April till July. This plant, being a native, might be thought quite hardy; but, when cultivated in cold situations, it sometimes requires a little winter protection. In its wild state on walls, it has very tough roots and firm stalks, and is seldom more than 6 or 8 inches high; and, in spite of being much exposed to winds and frosts, is far hardier than when grown any where in the garden.

The garden wallflower, *Cheiranthus cheiri*, is sometimes regarded as a variety of the indigenous species, but it really comprises at least a dozen pretty distinct varieties of its own, most of which were introduced from the South of Europe, so long ago as the year 1573,—and it always comes true and distinct from its own seeds, and cannot be obtained from those of the indigenous species. It has always a natural height of between 15 and 36 inches,—generally about 2 feet; it normally possesses in its flowers an orange or golden colour, yet commonly displays markings or stains or pervading tints of some dark colour between orange and blood, but, in this respect, has great diversity of character, and sometimes displays more yellow, and at other times more blood or bloody brown; and it sports into many subvarieties from seeds, and has produced a great number of most elegant and gorgeous double kinds, and can be fixed and perpetuated in any of its fine forms by the simple expedient of annual or biennial cuttings. Eleven of the oldest varieties of it, all kept up and propagated by means of cuttings, are the yellow double-flowered, *C. C. flore pleno*, with luscious spikes of double flowers, displaying a habit of inflorescence similar to that of the finest double stocks; the large-flowered, *C. C. grandiflorus*, with large-petalled yellow flowers; the largest, *C. C. maximus*, also with large-petalled yellow flowers; the saw-flowered, *C. C. serratus*, with serrated-petalled yellow flowers; the spreading, *C. C. patulus*, with double spreading yellow flowers; the rusty, *C. C. ferrugineus*, with brown or rust-coloured flowers; the flavescent, *C. C. flavescens*, with yellowish flowers; the various, *C. C. varius*, with variegated flowers; the thyrse-flowered, *C. C. thyrsoides*, with blood-coloured variegated flowers; the bloody, *C. C. sanguineus*, with dark or bloody brown flowers; and the double bloody-flowered, *C. C. hæmanthus*, with double blood-coloured flowers.

Some confusion of ideas prevails among cottage florists on the subject of the cultivation of the garden wallflower, occasioned by inadvertence to the distinction between it and other species, and between its own normal habit and the habit of its mere varieties. The wallflowers commonly called German, and somewhat recently come into notice, are readily produced from imported seed, and often develop themselves out of seedling state in extraordinary habit of growth and in semidouble fulness and singular colouring of flowers. They are well worth cultivating, and only require sowing in the open ground, planting out, when large enough, where they are to grow, and saving the seed for another year. Some are

very nearly double, yet differ widely from the ordinary double wallflowers, for they have the organs of reproduction and seed freely. As to common single garden wallflowers, the seed should be sown in June or July; and when they are up, they should be watered as often as required; and as soon as they are two or three inches high, they should be planted out in nursery beds, or where they are to remain for bloom. They will flower very early in the spring, and want nothing in the way of attention all through their culture, but keeping clear from weeds. The double wallflowers, whether the dark blood, the golden, or the pale yellow, are of a habit highly favourable for propagation. When the bloom is over, they require watering quite as much as when coming into flower; and it is a very good plan, when the flower is declining, to plant them out in the open ground, give them plenty of water, and pick off all the remaining flowers, as well as any that may be coming from side shoots. Soon after they have been so planted out, they will throw out shoots all over the stems. These are to be taken or stripped off as soon as they are large enough, and planted all over the space that can be covered with a hand-glass, not more than an inch apart. The soil must be rich and light, but not fresh manured; and when they are planted and well-watered, the glass must be pressed down close to exclude the air. Where this is done on a smaller scale, pots may be filled with the proper soil, loam, peat, and leaf mould, and the few cuttings placed away from the edges, so that a goblet or small bell-glass may be pressed down within the rim. In either case the cuttings will require occasional watering and shading until they have struck, when they may be potted, one in a forty-eight sized pot, and placed still in the shade, on a dry surface of ashes, or gravel, or slate, or paving of some kind, until the end of September, when they may be put into their winter quarters, which should be a common garden frame and light. But they should be covered only during the night and in hard weather; for it is impossible to give them too much air. Here they may be kept until they flower, after which, if they are to be grown another season, they must be shifted to pots of thirty-two to the cast, as soon as the bloom decays, and then all their shoots must be allowed to grow, instead of being taken off for cuttings. Plants of the second year, however, though they grow larger, bloom smaller flowers; and therefore wallflowers, like pinks and pansies and many other subjects, are annually raised from cuttings.

The other principal introduced species of wallflower are the pale-yellow, *C. ochroleucus*, about 9 inches high, carrying pale yellow flowers from April till July, thriving well in any common soil, propagable by radical division, and introduced from Switzerland in 1820; the tree, *C. arboreus*, about 3 or 3½ feet high, carrying yellow flowers from April till July, loving a soil of sandy peat, and introduced from Egypt in 1827; the firm, *C. firmus*, about a foot high, carrying yellow flowers from May till July, loving a soil of sandy peat, and introduced from Continental Europe in 1816; the alpine, *C. alpinus*, about 6 inches high, carrying yellow flowers from May till July, loving a soil of sandy peat, and introduced from Northern Europe in 1810; the fine-leaved, *C. tenuifolius*, about 2 feet high, carrying yellow flowers in May and June, loving a soil of loamy peat, and introduced from Madeira in 1777; the flax-leaved, *C. linifolius*, about 2 feet high, carrying purple flowers from March till August, loving a soil of sandy loam, and introduced from Spain in 1815; the ever-blooming, *C. semperflorens*, about 2 feet high, carrying white flowers throughout the greater part of the year, loving a soil of sandy loam, and introduced from Barbary in 1815; the changeable, *C. mutabilis*, about 3 feet high, carrying yellow and purple flowers from March till May, loving a soil of loamy peat, and introduced from Madeira in 1777; the long-leaved, *C. longifolius*, about 3 feet high, carrying white and purple flowers from September till December, thriving in any common soil, and introduced from Madeira in 1815; and the broom, *C. scoparius*, about 3 feet high, carrying white and purple flowers from May till October, but comprising also two varieties with respectively rust-coloured flowers and yellow and purple flowers, loving a soil of rich mould, and introduced from Teneriffe in 1812. Most of these require nearly the same treatment as the common garden wallflowers; only those from sub-tropical countries are comparatively tender, and need the protection of the greenhouse.

WALLNUT. See WALNUT.

WALL-PELLITORY. See PELLITORY.

WALL-PEPPER. See STONECROP.

WALLROTHIA. A small genus of hardy, exotic, tuberous-rooted, white-flowered plants, of the umbelliferous order. Two species, the tuberous about an inch or two high, and the shining about a foot high, have been introduced to Britain from respectively Hungary and the Pyrenees; and both bloom from May till July, and thrive in any common soil.

WALL RUE, — botanically *Asplenium ruta-muraria*. A curious indigenous fern, of the spleenwort genus. It grows on rocky places on the shore, and has bipinnate fronds and a height of about 4 inches, and carries a brown-coloured frutescence from June till October.

WALNUT,—botanically *Juglans*. A genus of monochlamydeous, hardy, deciduous, ornamental, fruiting timber-trees, constituting with the genus Carya the natural order Juglandeæ or Juglandaceæ. All the plants of this order are large trees, with pinnate leaves, small insignificant flowers, and esculent-kernelled nuts; and most are natives of North America. They belong to the Linnæan class *Monœcia* and order *Polyandria;* and the male flowers grow in oblong catkins,—

the female ones in sessile clusters. The botanical distinction between the true walnuts and the caryas is rather slender. See the article CARYA. Five species of true walnuts have been introduced to Britain,—one from Persia and four from North America; and all thrive well in any common soil, and are propagated from seeds.

The common or royal walnut, *Juglans regia*, is a native of Persia, and was introduced to Britain in 1562. It commonly attains a height of about 40 or 50 feet, and is capable of becoming a very large, lofty, and massive tree. Its head is globular and inelegant; its boughs are strong and spreading; its leaves comprise each from two to four pairs of leaflets, and a terminating odd one, and, when pressed between the fingers, emit a strong odour somewhat similar to that of apples; its leaflets are nearly equal in size, except that the odd one is the largest, and are entire, smooth, and shining; its foliage is thin, and of comparatively short continuance; its winter appearance is stiff, bald, and uncouth; its flowers are apetalous, and bloom in April and May; and its fruit is a smooth, coriaceous, oblong drupe, enclosing an irregularly grooved nut, with a yellow skin, an irregular knobbed surface, and a four-lobed, oily, eatable kernel. The principal varieties in cultivation are the largest-fruited, *J. r. maxima*,—the thin-shelled, *J. r. tenera*,—the late-vegetating, *J. r. serotina*,—and the cut-leaved, *J. r. laciniata;* and all these are similar in height, in time of flowering, and in general appearance to the normal plant.

The ornamental character of the common walnut is greatly marred by the lateness of the exfoliation, the thinness of the leaves, the baldness of the unleafed boughs, and the tameness of the outline of the head; yet it forms a pleasing diversity upon a pleasure-ground, and owes much to the distinctiveness of its foliage.—The timber is less beautiful for the finer kinds of cabinet work than mahogany, and more expensive, more difficult to be worked, and less clean in texture for the coarser kinds than beech; yet it takes a fine polish, and ranks next to mahogany for many purposes, and is in good esteem among cabinet-makers, turners, and gunsmiths.—The fruit is in much request, both in its green state for pickling, and in its ripe state for the esculency of its kernel.—The oil yielded by the fruit, and the marc left after pressing it out, are valuable. One bushel of nuts yields about 15 pounds of peeled kernels; and these will yield more or less oil, according as they are more or less dry,—but on the average, they yield about one half their own weight,—though the drier they are, and the less they yield, the better is the oil. The marc is excellent food for fattening hogs, and, like rape-cake or linseed-cake, it forms a powerful manure.—A good dye, of a dark yellow brown colour, is obtained by boiling the green husks without any mixture. The kernel, when rubbed on any crack or chink of a leaking vessel, stops it better than either clay, pitch, or wax. A decoction of the leaves, if sprinkled on gardens, kills earthworms, and if sprinkled on gooseberry bushes soon after they have put forth their leaves, defends them from the caterpillar.

The walnut will thrive as a timber tree or ornamental tree on any light dry soil; but will make little progress in a cold barren situation, and attains its greatest height on rich dry loam or on rich dry intermixture of vegetable mould and trap-rock debris; and it succeeds best as a fruit tree on dry calcareous soils, such as those of the chalk hills of Kent, or on light sandy loam superincumbent on either chalk or gravel. The best manure for the walnut is wood or turf ashes, spread in the beginning of winter, after the land has been well ploughed or trenched. Plants intended for timber-trees or park-trees should be raised from the seed, and removed direct to their final station. The walnut is very impatient of transplanting, and was long, though mistakingly, regarded by almost all cultivators as incapable of grafting. All the young plants of it require to be removed from the seed-bed with the utmost caution; and the knife should not touch the head of any, and should be applied but very sparingly to the roots. Trees designed to bear fruit, or otherwise planted in masses, must stand at distances from one another of at least 40 feet; and, on good soil, in an advantageous situation, may profitably stand at considerably greater distances. Plantations may be raised for the double purpose of yielding an annual crop of fruit throughout a series of years, and of then being felled for their timber. The trees want no pruning or particular care, and attain a large size in less time than the oak, and continue to bear well throughout a period of 20 years. Many subvarieties, as well as the well-defined and somewhat truer varieties, are in cultivation; but all more or less sport, or run into other subvarieties when raised from seed, and they therefore require to be propagated by budding or grafting; and, in consequence of their shyness, they need to be managed with much skill and care.

"The walnut-tree," says Mr. Knight, "appears hitherto to have effectually baffled, under all ordinary circumstances, the art of the grafter. The inserted scions wither and die, without apparently making any effort to unite themselves to the stock, or to draw nutriment from it; and consequently, the value of every superior variety has been limited by its use to the possessor of the original seedling-tree. It is true that a part of the seedling offspring of every fine variety generally inherits a portion of its good qualities; but I have found it extremely difficult to obtain from seed good varieties of sufficiently early habits to ripen well, except in very warm seasons; and I doubt much whether the value of the crop of walnuts, throughout the British Islands, be one-third so great as it would be if proper varieties were everywhere planted. The

walnut-tree may be propagated with more success by budding. I have succeeded tolerably well in some seasons, and in one season perfectly well; but in several others not a single inserted bud has been found alive in the following year, though all had been inserted with the greatest care. I therefore communicate the following mode of grafting the walnut-tree, which I found most perfectly successful under many unfavourable circumstances; and which mode, for reasons which I shall proceed to state, will, I believe, point out the means of propagating some other species of trees with facility, which have not hitherto been so propagated without difficulty and uncertainty. The fluid which the seeds of the walnut-tree contain, when that is fully prepared to germinate in the spring, and which was deposited within it for the purpose of affording nutriment to the seminal buds, or plumule, in the preceding autumn, is sweet, as in a great many other kinds of seed; but during germination this becomes, in the seed of the walnut-tree, bitter and acrid. Similar changes take place in the sap which is deposited, for analogous purposes, in the bark and wood of the walnut-tree, during the germination of its buds; and I was led by the discoveries of M. Dutrochet to infer the probability, that the sap during, and subsequent to, its chemical changes, might acquire new and more extensive vital powers, I therefore resolved to suffer the buds of my grafts, and those of the stocks, to which I proposed to apply them, to unfold, and to grow during a week or ten days; then to destroy all the young shoots and foliage, and to graft at a subsequent period. A severe frost saved me the trouble of destroying the young shoots, but it deranged my experiment by killing much of the slender annual wood, which I proposed to use for grafts; so that I found some difficulty in discovering proper grafts. The swelling of the small, and previously almost invisible, buds, within a few days enabled me to distinguish the living wood from that which had been killed by the frost, and the stocks were grafted upon the 18th day of May. My grafter had more than once been previously employed by me to graft walnut-trees in various ways, and never having in any degree succeeded, he did not seem at all pleased with the task assigned him, and very confidently foretold that every graft would die; and I subsequently found that he had insured to some extent the truth of his prophecy, by having applied grafts which were actually dead. The whole number employed was 28, and out of these 22 grew well; generally very vigorously, many producing shoots of nearly a yard long, and of very great strength; and the length of the longest shoot exceeding a yard and five inches. The grafts were attached to the young (annual) wood of stocks, which were between five and eight feet high; and in all cases they were placed to stand astride the stocks, one division being in some instances introduced between the bark and the wood, and both divisions being, in others, fitted to the wood or bark in the ordinary way. Both modes of operating were equally successful. In each of these methods of grafting, it is advantageous to pare away almost all the wood of both the divisions of the grafts; and therefore the wide dimensions of the medulla in the young shoots of the walnut-tree do not present any inconvenience to the grafter."

Green walnut fruit suitable for pickling should be gathered by hand from the tree when they are about one-half or three-fourths grown, before the outer coat and internal shell become hard; and only such as are freest from specks should be chosen. The common time of gathering them is the latter part of July and the former part of August.—Ripe fruit suitable for the esculency of the kernel should remain on the trees till the husk of some open at the valves and let out the nut, or at least till that of most or all becomes easily separable from the nut; and this commonly happens in the latter part or toward the end of September. But in Scotland, in the north of England, and even in backward situations much farther south, they seldom ripen at all; so that the planting of trees for the sake of producing them in these districts would be an absurdity. The ripe fruit, in consequence of its growing principally at the extremity of the branches, cannot easily or economically be gathered by hand; and it is commonly beaten off with long poles or rods ;—and this process breaks many of the points of the shoots, and causes the production of many cursons which afterwards bear flowers and fruits, and is therefore regarded as favourable to the prolificity of the trees, and is sometimes even practised upon a barren tree for the purpose of making it bear, but ought never to be done with any considerable violence, or with more than a gently beating action. As soon as the fruit are beaten down or otherwise gathered, they should be laid in heaps a few days to heat and sweat, so that their husks may readily separate from the shells; and after being cleared of the husks, they should be well dried a day or two beneath a well ventilated shed or in the open air and in sunshine; and then they should be stored away either on shelves in an airy room, or in a perfectly dry place beneath a twelve-inch layer of dry straw, or in jars or boxes among dry white sand; and if stored in the last of these ways, their shell will improve in colour, and their kernel be kept comparatively long and moist.

The black or Virginian walnut, *Juglans nigra*, is a native of Virginia, Carolina, Maryland, and Ohio, and was introduced to Britain in 1629. It grows to be a large tree, yet commonly attains in this country only about two-thirds the height of the common walnut. The young shoots are smooth and of a greenish brown colour; their leaves come out irregularly, and are large and fine-

ly pinnated, and comprise each from 8 to 14 pairs of leaflets and a terminating odd one; the leaflets are lanceolate, acute, and serrated, and the bottom pairs are always the smallest; the flowers are inconspicuous, and draw the attention only of botanists and the curious, and bloom in April and May; and the nuts have different shapes and sizes, but in general have a thicker shell and a rounder form than those of the common walnut, and are furrowed. Many varieties and subvarieties of the black walnut arise from seed, and may be perpetuated by grafting; and they differ from one another principally in the properties of the leaves and in the form of the fruit; and some of the more common or permanent popularly bear names descriptive of their peculiarities, such as the aromatic walnut, and the deeply furrowed fruited walnut. Specimens of the black walnut in a wild state, have been observed on the banks and islands of the Ohio river from 60 to 70 feet high and 6 or 7 feet in girth of stem. The timber of this species is much more valuable than that of the common walnut, but the fruit is inferior either for oil or for eating.

The grey or Pennsylvanian walnut, *Juglans cinerea*, is noticed in the article Butter-Nut (Grey).—The ash-leaved walnut, *Juglans fraxinifolia*, and the winged-fruited walnut, *Juglans pterocarpa*, are natives of North America, and have been introduced to Britain, and commonly attain a height intermediate between that of the common walnut and the black walnut.—Other species which popularly bear the name of walnut now belong to the genus carya.

WALNUT-TREE (Jamaica.) See Ajuapar.

WALTHERIA. A genus of tropical plants, of the byttneria family. One yellow-flowered biennial of about 2 feet in height, and four yellow-flowered shrubs, varying in height from 2 to 10 feet, have been introduced to the botanical collections of Britain; and 7 or 8 other species are known.

WAMPEE-TREE, — botanically *Cookia*. A small genus of exotic evergreen ligneous plants, of the orange-tree tribe. The dotted species, *Cookia punctata*, was introduced to Britain from China, toward the close of last century; it is a small tree of about 15 or 18 feet in height, carrying white flowers, and producing esculent fruit; and it loves a soil of light loam, and requires stove heat, and is propagable from cuttings.

WANGENHEIMIA. A curious, exotic, small, hardy, annual weedy grass of the wheat tribe. It is a native of Spain, and was introduced to Britain in 1776; it has a height of about 6 inches, and blooms in July and August, and will thrive in any common soil; and it constitutes a genus of itself, and bears the specific name of Lima.

WANG-TOOTH. A jaw tooth.

WANT. A mole.

WANTY. A broad leathern belt, used for binding a load upon a horse.

WARBLER. A large family of passerinous birds, distinguished by the straightness, slenderness, and bodkin-like form of the bill. It comprises the nightingale, the blackcap, the stonechat, the wheat-ear, the mill-clappers, the whitethroat, the fauvettes, the wrens, the wagtails, the meadow-larks, and a number of others; and many of the most common or most interesting are noticed in their respective alphabetical places in our work.

WARBLES. See Bots.

WARP. The ooze or slimy alluvial substance which constitutes the deposit left on land by the process of warping. See the article Warping of Land.

WARPING. Abortion in the cow. See the article Abortion.

WARPING OF LAND. The forming or renewing of soil by means of a sedimentary deposit from silty tidal waters. It differs from irrigation in employing marine water instead of river water, in forming a new soil instead of fertilizing an old soil, and in obtaining a deep solid deposit instead of procuring a mere filmy crust or soluble impregnation. It more nearly resembles the Italian operation called colmata than any other georgical process; but differs in employing salt water instead of fresh, and in obtaining a shallower deposit, and in a shorter time. See the article Colmata. It somewhat resembles also the enrichment of such valleys as those of the Nile and the Mississippi, which derive vast fertilization from silty fluviatile deposits, but differs from them in some of the same respects as from irrigation and colmata, and also in its being artificial, and wholly dependent for extent, frequency, and depth on the arts of the georgist. It can occur only on lands which lie lower than the level of high-water, and in the immediate vicinity of estuaries or tidal rivers whose waters are strongly charged with fine silt of composition suitable to constitute soil; and hitherto it has not been practised to any considerable extent in any part of Britain except the low districts of Lincolnshire and Yorkshire, around the tidal region of the Trent, the Ouse, the Dunn, and the other streams which form or feed the Humber.

The main portions of the warpable tracts in these districts naturally lie so low that they would be flooded by the tide of high-water but for being protected by strong embankments along the sides of the rivers. These embankments are of vast strength and size, and must have been a work of prodigious labour; yet when they were made, or by whom, no man knows. Considerable improvements were made during the reign of Charles I. by a company of Dutchmen, and a few Frenchmen, calling themselves Participants, who contracted with the Crown to drain a tract of about 75,000 acres south of Thorne, one-third of which was to become their own property, one-third to be appropriated by the Crown, and one-third distributed among the commoners of the

district; and among their numerous works, they widened the river Dunn, and turned its course into a new and artificial channel which enters the Ouse at Goole, and is now called the Dutch river. Some tracts also, which naturally lay higher than the level of high-water, have become available for warping by means of subsidence consequent on draining. Of this kind is a peat-moss of about 10,000 acres, called Thorne Waste, situated about two miles from the banks of the Ouse, with a bottom of sand, a basal stratum of prostrate forest, a general body of very spongy peat, and a maximum depth near the centre of about 18 feet. In bygone days, when the rivers were not contained within their present banks, they must have had a natural flow up to the margin of this peat-moss, which at that period must have been above the level of the tide at high water; but years and ages passing by, and drains having been cut through the cultivable land, a considerable tract of this peat-moss became in a certain way drained, and of a much lower level than it originally was, and consequently proved capable of being covered by the tide-water from the river Ouse.

The practice of warping was first tried about the year 1743, by Mr. Richard Jennings of Armin near Howden; and was not tried by any other person till about ten years after; and remained in obscurity till enquiries, consequent upon the institution of the Board of Agriculture, in the winter of 1793. It was long done on a very limited scale, the sluices or cloughs then used being merely what now would be called shuttles; and the deposit at first was very small, from want of power consequent on the smallness of the works. Gradually, however, the benefit became more generally known, and the works were made larger. In 1821, Ralph Creyke, Esq. entered into an agreement with certain proprietors of land in the townships of Goole, Swinefleet, and Reedness, for the purpose of warping their land; an act of parliament was obtained; and he commenced excavating a large main drain to convey the tide-water from the river Ouse, through the old cultivated land to the barren and uncultivated morass about to be improved. The sluice or clough was built of stone, with two openings of 16 feet each in width, and 19 feet in height from the sole to the crown of the arch, with four substantial doors, made when shut to oppose the entrance of the tide, yet with power at will to keep them open for the admission of the tide during the time of warping, by means of strong staples and iron rods fixed in the stonework. The main drain was very large, it having been proved by continued observation and calculation, that the area of a warping-drain ought to be three times that of the sluice, to prevent as much as possible any considerable resistance to the flow of the water; its dimensions were 30 feet wide at the bottom, 90 feet wide at the surface of the land, and 11½ deep; the banks were placed 9 feet from the edge of the main drain, the base of each bank was 60 feet wide, and they were 10 feet high; this main drain extended originally for near 3 miles, and cost, with the purchase of land and erection of sluice, about £18,000. This main drain and its extension have for some time been used as a canal for vessels of about 75 or 80 tons burthen, and are found very convenient for the purpose of conveying one of the chief productions of the warp-land, namely, potatoes, to the London market, where they command a high price under the name of Yo k-shire Reds.

In commencing the warping of any plot of land, it is first enclosed with banks, the size of which varies according to the extent and the level of the land. The general batten or slope of the banks is from 15 to 18 inches on each side for every 12 inches' perpendicular rise; and they are left from 2 to 3 feet wide at the top; and particular care must be taken in erecting them to procure the proper levels. The main drain being cut up to the newly-embanked compartment, the tide is suffered to flow in. At first it is very advisable only to take rather small tides in, beginning to admit the water before they are at their height, and allowing them to increase by small degrees; for the banks being generally made of very porous materials—that is, peat-moss and bad sand—they are subject to leak very much, and in some instances considerable damage has been done by a breakage of the bank. In case of a bank being rather exposed to the action of the wind, which is one of the greatest enemies that a warper can have to contend with, it is generally what is called 'puddled;' that is, a trench from 2 to 3 feet wide is cut longitudinally through the centre of the bank into the foundation, the material is chopped up and mixed with water, which being pressed down and beat by repeated treading, becomes a solid mass. The water is allowed to flow over the land during the spring-tides. The reason why the spring-tides only are generally made use of is, that the neap-tides are much smaller in body of water, and although they might in certain instances be of sufficient height to flow the land, yet as one of the greatest difficulties in warping is to keep the main drains in order by preventing the warp from being deposited in them, and as that is chiefly done by the return of the water from the compartment under the process, which in spring-tides being a larger body of water, scours out the drains, in neap-tides there would not be sufficient flow, and they would be warped up.

The water conducted by the main drain into the embanked allotment is more or less divided into smaller ones, called 'inlets' (which vary much in size), and conducted to different parts of the compartment; for wherever the current, leaving a drain, expands itself, there the greatest quantity of warp is deposited. As soon then as the plots of land next the mouth of the inlets

have a sufficient quantity of warp deposited, the inlets are extended by what are called 'call banks,' which, though much smaller than the others, still conduct the current onward to parts not acted upon by the currents before, and so on according as required. One of the greatest niceties in warping is to have the land finished as level as possible, which can only be done by the strictest attention, and by proper judgment in conducting the different currents, which must not be suffered to cross one another, or to meet, as in such a case the deposit of the warp is less, not so regular, and of an inferior quality. Care must also be taken that the currents should not be too strong, for in warp there is a considerable portion of sand which, being the most heavy of all the particles floating in the water, sinks first, the lighter particles being carried on by the violence of the current, consequently a sand-bed is formed. These sand-beds, however, if covered afterwards with warp, generally are found to crop better than warp which may be too strong. With respect to the depth of warp deposited, it depends much upon the level of the land to be warped; for, should the land be very irregular, in some places there would be a great deposit, and in others only comparatively a small one. It is generally advantageous to have the land to be warped as level as possible. A deposit may then be obtained of from 1 to 3 feet, and in some favourable instances it has been considerably more, but it cannot be generally calculated on.

The time it takes to warp a compartment cannot be very accurately defined, there being many circumstances to take into consideration. Some of the compartments are much farther from the mouth of the drain than others; in addition to which, should the lands to be warped be very low, they can only take in perhaps every second tide, and even sometimes only every fourth, on account of the difficulty of getting the water back again, for the tide continues to flow into the compartment until perhaps nearly low water in the river. The tide then returning, as it does very rapidly, prevents the water from flowing out of the drain, and would fill the compartment too full of water. The doors are consequently closed against the tide. They open themselves, however, when the water in the river is of a lower level than that in the drain. When the compartment is near the river, that does not occur, as the water has time to get off before the tide returns. The seasons also vary very much; but with a large main drain, and in a fair average season, from 350 to 450 acres might be warped in two years, or two years and a half. The immense size of the main drain which has been mentioned, and its consequent great power, facilitate very much the warping of land of a higher level than that which could be warped by a small drain; for the current being forced on by the great flow in the drain, can be made to flow over the high ground by turning a drain towards it, provided that there be sufficient land of a lower level on the other side to draw onward the water so forced over the hill. The warp so deposited is at first of an inferior quality, the current being so strong; but in a short time the peat-moss becomes pressed down by the weight of the deposit. The current is then easier, and the deposit becomes better.

It may be asked, whence comes this inexhaustible supply of mud or warp? An immense quantity of it floats about the Humber and its tributaries; and opinions widely differ as to whence it comes. Considerable ravages have been made by the sea on the coast of Holderness, extending all the way from Bridlington Quay to Spurn Point; but as the Humber is comparatively clear at the mouth, it is difficult to say whether it can come from that source. It does not come directly from land-floods, as these always deteriorate, for the time, the deposit, although considerable deposit being carried down into the Humber by land-floods, may return in the shape of warp. The greatest probability is that it arises from the action of the tide on the immense and almost hidden beds of soil which form the bottom of the Humber. It appears, however, that the warp is full of seeds of different sorts, more particularly the white clover, which it grows in great abundance, and quite naturally. The quantity of warp in the water differs considerably; there is more in the water during fine and dry weather; and the deposit is greater when there is no wind. It is highly advisable, if possible, to avoid finishing the warping of a compartment during the very fine and hot weather of June and July; for the tides are small at that period of the year, and are apt to be strongly impregnated with saline particles, which, being left in the warp, have a very injurious effect in retarding vegetation. The expense of warping cannot be laid down with any certainty, as the different compartments vary so much; when the land to be warped is very low, the banks require to be so much higher; and the internal works are very expensive, should the general surface of the land be irregular. There is a great difference between the flow and the ebb of the tide in the river Ouse and the neighbouring rivers, the flow only taking three hours, consequently running with great rapidity, and the ebb taking the remaining nine hours. The tides frequently flow as much as from 18 to 22 feet.

The general benefit to the country from warping cannot but be very apparent, it having created a steady demand for labour throughout the whole of the district where the improvements have been carried on. Between 3,000 and 4,000 acres of land have been brought into a state of cultivation; and where formerly was a morass may now be seen the finest crops of wheat, clover, and potatoes. The original rent was in many instances nothing — now a rent is received of from 35s. to 50s. per acre. The most general

course pursued in the cultivation of the newly-warped land is to grip it every 4 or 5 yards, throwing the soil taken out of the grips on to the land, amongst which, as soon as it is tolerably dry (the season, of course, permitting), oats, and red and white clover, and rye-grass, are sown. The oats are not expected to be a good crop: they are merely sown as a protection for the seeds, as what is chiefly wanted is to have a good coating of seeds. They are sometimes pastured, and would be better to remain so for two years; and they are then followed by wheat or potatoes.

These statements, however, apply principally to low marsh land within manageable distance of the great canal drain; and, indeed are abridged from a report in the Journal of the Royal Agricultural Society which has special reference to Thorne Waste. But warping, on the same principles, in a similar way, and with similar results, is equally practicable on all sorts of low lands within reach of the tidal waters of the Humber, whether peat, sand, or clay,—whether soft or hard, porous or retentive; and the soil which it forms varies both in fertility and in adaptation according to the circumstances of the locality, the composition of the warp, and the manner, season, and duration of the floodings. The best months for the operation, because the driest, are June, July, and August. Some warped land is very stiff, and some very pliable; and the two qualities sometimes occur in the same compartment, and in frequent alternation. The land nearest the drain is generally the lightest, in consequence of its receiving the first and heaviest depositions of silicious matter from the floodings; and the land farthest from the drain is generally the best. The produce of warped land is exceedingly varied, according to the original quality of the soil, the course of husbandry pursued, and the length of time since the warping; but, in a general view, it amounts to from 20 to 40 bushels of wheat per acre, from 5 to 8 quarters of oats, and from 35 to 70 bushels of beans. No warped land does well for grain or flax or potatoes till after it has been two years or so under grass seeds; but all the best or even middle-rate kinds of it, after two years of grass seeds, are capable of yielding a good crop of wheat,—and, though liable to be infested with the slug, may be freed from this foe by means of a surface strewing of salt after the wheat-seed has been sown. But warped lands of all kinds require manure, and will not carry many crops without its aid.

WARRANTY. A formal written declaration, on a stamp receipt, that a horse sold to a purchaser is, at the time of sale, perfectly sound, free from every kind of vice and blemish, of a specified age, and, if a saddle horse, quiet to ride, —if a draught horse, steady in harness, and not given to kicking, rearing, or jibbing. This declaration, accompanied with a written agreement to rescind the bargain if the warranty should prove incorrect, empowers the purchaser to return the horse and get back his money, on proving that any unsoundness, vice, or unquietness existed at or before the sale; and even the declaration itself, without the agreement, entitles him to raise an action for the price. No verbal warranty of any kind, no warranty which may be presumed or argued from highness of price or circumstances of sale, and no correct written warranty on unstamped paper have any legal force. The paper employed should be a stamp receipt for the price of the horse; and the form of expression should be "Received of —— —— the sum of —— —— for a —— —— warranted," &c.

WARRATAH. See Camellia.

WARREN. A piece of ground privileged either by prescription or by royal grant for keeping in a wild state large numbers of game, quadrupeds, game birds, or similar animals, particularly rabbits, hares, partridges, and pheasants. But the word, in modern times, is used almost exclusively in reference to a burrowing ground for rabbits. See the article Rabbit.

WART. A small spongy tumour on any part of the body of an animal. It commences on the cuticle, and afterwards becomes seated on the true skin. Warts are not uncommon on the muzzle, the eye-lids, the ears, the neck, the belly, the penis, and the prepuce of horses; and they frequently cause much annoyance, and require to be removed. A small-necked one may be nipped off with a pair of scissors, and afterwards touched with lunar caustic; a larger-necked one may be tied firmly, and more and more tightly, with a ligature of waxed silk till it die and fall off from want of nourishment from the blood; and a broad-based one may either be slowly reduced by frequent applications of caustic, or removed at once with the knife, and seared with a red-hot iron.

WART-CRESS,—botanically *Senebiera*. A genus of herbaceous plants of the cruciferous order. Two species grow wild in Britain; one white-flowered annual species, the Nilotic, has been introduced from Egypt; and five other species are known.

The common or buckhorn species, or swine's cress, *Senebiera coronopus*, called by some botanists *Coronopus Ruellii*, abounds on waste grounds and roadsides in many parts of Britain. Its root is annual and tapering; its stems are short, spreading, branched, leafy, and smooth, and lie quite flat on the ground; its leaves are deeply pinnatifid and somewhat glaucous; its flowers grow in dense corymbs, and come out opposite to the leaves, and are small and white, and bloom from June till August; and its silicles grow in dense clusters, and are much shorter than the leaves, kidney-shaped, notched, and furrowed. This plant is, in a certain sense, eatable, but has acid, fetid, and nauseous properties, and requires to be very abundantly boiled.

The lesser or pinnatifid species, *Senebiera pinnatifida*, called by Linnæus *Lepidium didymum*, and by Smith *Coronopus didyma*, grows on rubbly spots and waste grounds near the sea in the south of England. Its root is annual, small, and fibrous; its habit is similar to that of the common species; its stems are procumbent, branched, leafy, finely hairy, and a foot or more in length; its leaves are deeply pinnatifid, smooth, and flat; its flowers come out in clusters opposite the leaves, and are numerous, small, and white, and bloom in July and August; and its pouches are distinctly two-lobed and turgid.

WARTWORT. See EUPHORBIA.

WASHING OF SHEEP. The cleansing of sheep from coarse dirt upon their fleece, preparatorily to their being shorn. On some hill farms, this process is omitted; and on others, where the flocks are very large, it is performed simply by compelling the sheep to swim three or four times across a stream; but on select hill farms, and on most large farms of the mixed husbandry, it is commonly done in some such manner as the following:—The washing pool may be made in any part of a rivulet which is deep enough to take a man at least mid thigh. The bed of the rivulet must be pebbly, and not muddy; and this character it will possess if a gentle current passes through the pool. If no suitable rivulet be near, a pool must be made by damming. The sheep must be brought to one of the banks of the pool, so that, when they are removed from the water, they may have grassy ground to stand upon, in order that they may keep themselves clean. At least three and at most five men will be necessary to stand in the water, so arranged that the first who operates shall be lowest down the stream, and the last shall be the shepherd or chiefly responsible person himself; and there should be plenty of hands to keep the sheep near the edge of the water, as the ewes have a strong desire to wander away in search of their lambs, and require to be restrained; and a piece of the ground also may be netted or hurdled in, to keep all from wandering. Every thing being thus prepared, the first man at the water's edge gets a sheep brought towards him; and this he seizes and pulls into the water, and immediately turns over on its back, holding the arm of the foreleg with the left hand, and grasping a portion of the wool at the side of the head with his right. He swings the sheep in the water, turning it over on its one side, and then on its other; and at the same time he pulls it gently backwards and forwards, from and to him, at every successive turning. In this process the wool waves up and down in the direction of the length of the body, and swirls round the body first in one direction, and then in another. He then hands the sheep to the next washer, who repeats the same operation; and he to the next, till the shepherd gets it, who, after feeling the skin with his hand, and judging by the clear state of the water, of the cleanly state of the animal, dips it over the head, and turns it gently over on its feet, and assists it up the grassy bank. The sheep stands for a while dripping and wobegone; but at length, twirling its wool like a mop, and making the spray fly from it in a shower, it forgets the rough handling it has passed through, and crops the green herbage in contentment. By this operation, the body being in an inverted position, the skin and wool of the sheep are cleaned, as if they had been washed with soap and water; and, in fact, they have been so washed, for the oil or yolk of wool presents similar chemical components to soap. The surface of the water may be seen covered with greasy matter and filth, which are carried away gradually by the current. The washed sheep are put, till they are shorn, into a clean grass field, where they cannot dirty their wool under banks of earth.

A wash-dike, in many instances, is formed for the use of a whole district, and let out for a small sum per score; and either in this case, or upon a large farm, it may possess higher facilities than in the simple plan which we have noticed,—and, in particular, there may be a floodgate in the middle of the dam to regulate the accumulation and flow of water, a pen for the sheep before the washing, a fenced path to direct and confine their ascent up the bank after the washing, a channel and parapet for the process of washing, and suitable accommodation for the work-people and their clothes and implements. —The process each day ought to terminate before three o'clock in the afternoon, so that all the sheep may have time to become somewhat dry and warm before the cool of the evening. Water containing any calcareous impregnation is unsuitable on account of rendering the wool rough and brittle; and water of any kind popularly called hard will not clean so well as any kind of pure soft water.—Some good judges think that the whole process would be much more efficiently and economically done by first immersing the sheep in a tub of blood-warm water till their fleece should become softened, and then rapidly and sousingly washing them in a pool; and Bakewell, who was one of these, maintains, "that the keeping of the animal a sufficiently long time in the water endangers its health,—that fleeces of a close pile cannot be cleansed by the usual mode of washing,—and that the extra labour required to wash sheep in tubs with warm water would be amply repaid, were the first and second washings carried out and applied as manure, the quantity of rich animal soap which it contains making it one of the most fertilizing applications which can possibly be used."

WASP,—scientifically *Vespa*. A genus of insects of the diplopterous family of hymenoptera. The antennæ have thirteen distinct joints, and have an elongated, pointed termination; the mandibles are strong and dentated, hardly longer

than wide, and broadly and obliquely truncated at the extremity; the clypeus is large and nearly square,—and the middle of its anterior margin is widely truncated, and has a tooth on each side; the ligula is short or but slightly elongated; and the abdomen is ovoidal or conical. The individuals of each species live in large societies or communities, composed of males, females, and neuters; and all the females and neuters are armed with an extremely powerful and venomous sting. The nest or domicile of a community consists of a variable number of combs or amassments of cells; it is constructed by the females and the neuters with a pultaceous substance, similar to paper or pasteboard, formed out of particles of old wood or bark, detached with the mandibles, and afterwards moistened and reduced; it usually comprises horizontal ranges of combs, suspended by one or more pedicles, and has on its inferior side a range of vertical cells in the form of hexagonal and truncated pyramids; and in some cases it is exposed, but in others is surrounded by an envelope, which has a common and generally a central opening, and to the parietes of which the combs adhere, whether they be in the open air, or hid in the earth, or concealed in the hollows of trees. A few females alone are alive at the beginning of each season, and they found the communities by laying eggs, which produce neuters; and these, when matured, assist in enlarging the nest and taking care of the succeeding young ones. The larvæ are vermiform, and destitute of feet, and, as well as the pupæ, inhabit each a separate cell; and all which cannot complete their metamorphoses before the month of November are put to death and dragged from their cells by the neuters. The males and the young females make their appearance in the beginning of autumn; and all the males, all the neuters, and some of the females perish on the approach of winter, leaving only a few females to survive till spring and found new communities. The males never work. The larvæ lie with their head downward; and, when about to pass into the pupa state, they shut themselves up and spin a cocoon. The females and neuters feed principally on fruit, and nourish the larvæ with its juices.

Six species of wasp, if not more, occur in Britain; but the principal are the hornet, the common wasp, and the small wasp.—The first is noticed in the article Hornet.—The common wasp, *Vespa vulgaris*, is about eight lines long, of a predominantly black colour, with a yellow patch and black point in the middle on the front of the head, several yellow spots on the thorax, four yellow spots on the scutellum, and a yellow band with three black spots on the posterior margin of the rings of the abdomen. The males are smaller in size and sting less than the females; and the number of each in a community is nearly equal, and commonly amounts to between 200 and 300; but the number of cells in a vespiary often amounts to more than 10,000, and each cell serves for three ovule deposits or three successive larvæ in a year, so that the total number of wasps produced in one community in a single season may amount to 30,000. The nests are built in the ground, and consist of a substance so very like paper that only a keen observer could discern the difference. — The small wasp, *Vespa coarctata*, resembles the common wasp in almost every thing except the size of the body and the form and habitat of the nest, —the latter having an oval outline, and being usually suspended from the branches of trees, and coated with a kind of varnish which renders it impervious to moisture.

"Few insects," says Mr. Duncan, "are more troublesome to horticulturists than the wasp; and all their care can scarcely prevent it from annually appropriating a share of the choicest produce of their labours. Proverbially pert, irritable, and intrusive, confident in its hard coat and formidable sting, this winged pest is ever on the watch for some sweet morsel, and almost every kind of fruit is attacked with eagerness. Pears, apricots, and plums seem, however, to afford its most favourite repast, the latter especially; for, according to a local English rhyme,

> "When the plum hangs on the tree,
> Then the wasp you're sure to see."

It is even alleged, that those seasons most favourable to the growth of plums, produce the greatest number of wasps, a coincidence which may well occur, for dry and warm weather is beneficial to both. The number of these insects varies greatly in different seasons, and occasionally from causes which we cannot appreciate. Thus, in the summer of 1836, so few appeared in England, that the circumstance was remarked even by those who are least observant of such things; in 1814, on the contrary, they abounded to a most extraordinary degree in every part of Britain. It is well known that the whole inhabitants of the vespiary perish in the winter, except a few females, who continue in a torpid state during the inclement season, and revive in the spring; on these devolves the whole duty of constructing a nest and founding a new republic; it may be supposed, therefore, that an unusually severe winter, or a cold and backward spring, would either entirely destroy a portion of these few solitary matrons, or so interfere with their operations for continuing the species, as to diminish the entire brood throughout the year. It is not, however, of their paucity we have in general to complain, but of the difficulty of getting rid of those that visit us. The existence of solitary females in spring, on whom the continuance of the race entirely depends, shows what effect would attend any measure taken against them then. In the north of Scotland, where we have seen wasps so abundant as to become a very serious evil, we have known instances of

boys being employed to catch them at that season, being paid at so much per head. As there is as much amusement as profit in such a bee-hunt, they generally proved very successful; and a similar step may be safely recommended to all that suffer from this cause. When infesting the fruit-trees in numbers during the autumn, one of the best and most common means of destroying them is that described by the author of the "Splendid Shilling," in a poem, which deserves to be known to horticulturists, written in praise of "Cider:"—

"Myriads of wasps now also clustering hang,
And drain a spurious honey from thy groves,
Their winter food,* though oft repulsed, again
They rally undismayed; but fraud with ease
Ensnares the noisome swarms; let every bough
Bear frequent vials, pregnant with the dregs
Of moyle or mum, or treacle's viscous juice;
They, by the alluring odour drawn, in haste
Fly to the dulcet cates, and crowding sip
Their palatable bane; joyful thou'lt see
The clammy surface all o'erstrewn with tribes
Of greedy insects that, with fruitless toil,
Flap filmy pennons oft, to extricate
Their feet, in liquid shackles bound, till death
Bereave them of their worthless souls. Such doom
Waits luxury, and lawless love of gain."

The most attractive composition of this kind is vinegar and water, mixed with a little honey, sugar, or treacle. A bee-hive recently emptied of its contents, and still smelling strongly of honey, if exposed in a suitable place will attract a great number of wasps, and if bottles filled with some similar liquid be placed in or near it, many may be thus destroyed. But a more effectual mode of destruction than any of these is to suffocate them in their nests. A writer in the Memoirs of the Caledonian Horticultural Society affirms, that he found it easy to discover the nests, by observing, in a quiet sunny day, the course of the flight of the wasps from the garden, following them as far as he could notice them flying, then waiting till others passed the same way, which he likewise followed, and so on till he reached their habitation. Having discovered the nest, various methods may be adopted to destroy the inmates; but this should never be attempted but in the evening, when the whole colony is within, and can easily be taken by surprise. The writer just referred to introduced a match of damped gunpowder, which burnt like a squib, into the entrance-hole, then put his foot on it for a few minutes, and afterwards dug till he found the combs, when he threw a pailful of water upon them, and trod the whole together like mortar. In this way he destroyed fifty nests within 300 yards of his garden, without receiving a single sting. Rags dipped in sulphur will be found to answer the purpose perhaps better than anything else. The entrance to the vespiary should be a little widened, and the lighted rags introduced; the hole should then be partly closed with small stones, but not so as wholly to exclude the air, which is necessary to keep up the combustion. In regard to the pendulous nests, it will be sufficient to apply the sulphur-rags or matches to the lower extremity, where the entrance-hole is usually placed.

"It is of very great importance that these marauders should be excluded from hothouses, as the delicate fruits there cultivated are speedily disfigured by their attacks; but this is no easy matter to accomplish, as the means taken to admit air, so indispensable to such places, usually give free access to the insects likewise. Grapes are sometimes enclosed in paper or gauze-bags, which is both a troublesome and clumsy expedient. There seems to be no great difficulty in covering such portions of the frame-work as require to be opened, with some kind of coarse gauze or wire-cloth, for insects do not readily pass through an obstacle of that kind, even when the meshes are pretty wide. Mr. John Dick recommends for this purpose a kind of cloth which he calls scrime. This individual has likewise invented a canvass screen for covering wall-trees, which appears to be exceedingly well adapted for the purpose, as it not only proves an effectual protection from wasps and such-like insects in the autumn, but also serves to protect the blossoms from frost in the spring. A description and figure of it will be found in the 4th Volume of the Memoirs of the Caledonian Horticultural Society, from which body he received a reward for the invention.

"Wasps are deservedly objects of peculiar dislike to the cultivators of the honey-bee. In the autumn, they sometimes hover about the entrance to the hive in considerable numbers, at times killing the bees (which they do very adroitly, suddenly pouncing upon them, tumbling them on the ground, and with their serrated jaws speedily separating the abdomen, which contains the honey-bag, from the hard and sapless thorax), and frequently entering the hive in spite of all opposition, and feeding on the honey. 'We have often observed one of these marauders,' says Dr. Dunbar, one of the most skilful apiarians of the present day, 'enter a hive with fearless intrepidity, and, watching its motion through the glazed frame, have been astonished by its feats of strength and agility. In ascending the combs, it is, of course, instantly attacked by the rightful inhabitants; if one only venture to assail it, the unfortunate bee has no chance of victory, and but little of escaping with life; if five or six cluster round it, as is generally the case, and cling close to its body, endeavouring to pierce it with their stings, their efforts are set at nought by the intrepid wasp, which struggles with unwearied obstinacy, rolls along the floor of the hive so closely enveloped in a mass of bees, that but little of its body is visible; and though at last it is forced by overwhelming numbers to

* Few require to be told that the poet is here in error, wasps never laying up a store of provision for the winter.

take to flight, it flies off apparently uninjured from the conflict. These partial attacks of single wasps, however, are of little moment, farther than that they are, perhaps, exploratory; it is when they come in a body that the safety of the hive is endangered; in such cases the utmost care of the bee-master is often unavailing. The wily insects soon discover the weakness of any particular hive in point of population, and, acting on this discovery, attack it in such numbers, that nothing but its removal can save it from speedy and utter destruction.' There is perhaps no effectual means of preventing the inroads of an enemy of such superior strength, and seemingly so insensible to the only weapons of offence which bees can employ. But we have known instances in which much good has been done by diminishing the size of the entrance-hole almost to the dimensions of a bee's body, and forming a narrow covered way to some distance without it: only one wasp can thus make its approach at a time, its movements are impeded, and the defence more easily made good."

WASTE. The demolition or unlawful removal of any structure or part of a structure which has in law the character of a fixture. See the article Fixtures.

WASTE LAND. Land which is incapable of cultivation till it be reclaimed and improved. It comprises many kinds, from mountain to marsh, and from inland downs to sea-beech sands,—and many gradations from bare rock to tangled brushwood, from absolute sterility to comparative productiveness, and from the scantiest and shallowest pastoral soil to deep, easily improvable, and constitutionally rich land, of texture suitable for tillage.

According to the evidence of Mr. Cowling before the Emigration Committee in 1827, England contains 3,454,000 uncultivated acres and 3,256,000 unprofitable acres, Wales 530,000 uncultivated acres and 1,105,000 unprofitable acres, Scotland 5,950,000 uncultivated acres and 8,523,930 unprofitable acres, Ireland, 4,900,000 uncultivated acres and 2,416,664 unprofitable acres, and the small British Islands 166,000 uncultivated acres and 569,469 unprofitable acres.

A law enacted in the second year of Edward VI. says, "that all such barren heath or waste ground, which before that time had lain barren, and paid no tithe by reason of the same barrenness, and now or henceforth shall be improved and converted into arable ground or meadows, shall from henceforth, after the end and term of seven years after such improvement fully ended and determined, pay tithe for the corn and hay growing upon the same;" and this law gave rise to conflicting opinions and angry litigations, and came generally to be interpreted with a decided leaning to the ecclesiastics, but was at last, after a long-contested suit, decided by three different juries to mean that "where the first crop shall be inadequate to pay the whole cost of cultivation, lime, &c., tithes are not payable for the succeeding seven years."

Mountainous, hilly, and steep waste grounds, clothed with dwarf or stunted heath, and also all other kinds of waste grounds clothed with heath, are discussed in the article Heaths; mountainous, hilly, and steep waste grounds, possessing a thin soil, and producing a short dry herbage, in the article Pasture; mountainous, hilly, and steep waste grounds, capable of most economical improvement by planting, in the articles Plantation, Planting, Coppice, and Orchard; moorish waste lands, in the articles Moor and Heaths; boggy and morassy waste lands, in the articles Bog, Peat, Fen, Marsh, and Morass; meadowy waste lands, in the articles Meadow, Irrigation, and Grass Lands; calcareous and drifting waste lands, in the article Downs; and waste lands subject to inundation by the freshets of rivers and the tides of estuaries, in the articles Embankment, Colmata, and Warping of Land. Some of the causes and indications of the most common kinds of sterility in waste lands are noticed in the article Barren Soils; some general remarks on the reclaiming and fertilizing of waste lands occur in the article Improvement of Land; and the principal arts and practices necessary for the reclamation of waste lands are discussed in the articles Draining, Paring and Burning, Subsoil-Ploughing, Enclosure, Lime, Manure, Fallow, Stone, Rolling, Fern, Furze, Heaths, Bog, and Irrigation.

The following rules respecting the improvement of waste lands are propounded by Sir John Sinclair:—"1. Not to put in practice any scheme of improvement, without the fullest deliberation, nor without the command of an adequate capital. 2. Not to begin on too great a scale, nor until, by experience it be found, that the design is suitable to the soil, situation, and climate. 3. When the intention is to cultivate bogs, or peat mosses, not to begin cropping, till at least one season after the drains are completed, and the soil thoroughly reclaimed from superfluous moisture. In bogs abounding with fluid matter (flow mosses), a longer time is necessary. 4. To plough or delve peat-moss in autumn, that it may first be effectually exposed to the winter frost and rains, and not to the summer's heat, which would harden it, and prevent its decomposition. 5. Whatever is done, to do it effectually; not to think of laying on four acres, the manure necessary for three, nor the lime, chalk, earth, clay, sand, or gravel, upon two acres, that should be employed in covering only one. 6. To carry on the improvement of waste lands, without encroaching upon the dung necessary for the improved part of a farm, as dung ought never to be brought from a good soil, to lay upon a bad one. Unless dung therefore can be procured from a neighbouring town or village, it will be better to leave the lands in their natural state, except in cases, where the soil, by being pared,

burnt, limed, or marled, or covered with chalk, clay, earth, &c. will pay the expense of the improvement, and rendered so fertile, that it can afterwards be preserved, in a good condition, from its own resources. 7. To lay down any land, improved from waste, in high and bleak situations, as soon as possible into grass, and to retain it in that state as long as it is tolerably productive. For though grain and roots may be cultivated on waste lands, when properly improved, and favourably situated, yet grass pastured, particularly by sheep, is principally to be depended on for improving weak soils, in barren districts, and remunerating the improver."

"It has been thought," says the same distinguished writer, "that greater profit may be derived from the improvement of wastes, or of lands not hitherto completely cultivated, than of similar soils that have been long under the plough. The rent is necessarily lower, they are freer from weeds, and if once brought into good order, and properly managed afterwards, will give lucrative returns. Instances might be stated in support of the above doctrine, but unfortunately it has not in every case been sanctioned by experience. The real cause is, that a great expense must be incurred in the first instance, while the subsequent advantages are uncertain. —Among the various modes of improving wastes, that of bringing them into a state of cultivation, by establishing colonies of labourers, fishermen, tradesmen, &c. in advantageous situations, has been found beneficial to the proprietor and to the public,—to the first, because his land is improved, perhaps without any expense being incurred by him,—and to the second, because, as a distinguished character has well observed, when land is given to a cottager for a number of years, under a small reserved rent, he and his family will exert in its cultivation, a quantity of labour, which would not otherwise be called into action; and by which, many thousand acres of land may be cultivated, which would not, in any other mode, pay the expense of improvement.—Whether exertions for the improvement of wastes are beneficial or injurious to the undertaker, there can be no doubt, that they are advantageous to the public. By these means, thousands of acres have been already added to the national stock of arable land, which, in proportion to their extent, will continue to yield food for our increased population. Besides the multitudes employed in reclaiming these wastes, occupation is provided for as many persons as are requisite for their subsequent cultivation; and the surplus food, beyond what the actual cultivators may require, increases the fund of provisions for maintaining those who are employed in manufactures and commerce. In all these respects, the improvement of waste and unproductive land is an object of very high national importance, and well deserves the attention, and indeed the encouragement, of the legislature."

WATER. Water, in a perfectly pure state, consists of 88·89 per cent. of oxygen and 11·11 of hydrogen. These two elements, in their separate or gaseous state, will not combine except by electrical agency; and though confined in one vessel, they will only diffuse themselves through each other, and will not make any attempt to unite till so attacked by either a voltaic spark, a red heat, or a strong pressure as to excite electrical action. A mixture of oxygen and hydrogen in a close vessel when electrically acted on, explodes and forms water; a stream of hydrogen escaping into the air, if ignited, will combine with the oxygen of the atmosphere in a process of regular combustion, and form water; and the free hydrogen which arises from many a process of decomposition on the surface of the earth, and ascends to the higher regions of the atmosphere, combines under the action of free electricity with the oxygen of the air, and forms much of the rain which falls in torrents during thunderstorms. The amount of electrical power necessary to maintain the union of oxygen and hydrogen in every grain weight of water is equal to a heavy flash of lightning. Water is, however, decomposed by electricity in excess, and its specific electricity liberated; and this fact may account for the formation of nitrous acid gas in the air during thunderstorms. The electricity compels the union of atmospheric nitrogen with oxygen yielded by either the decomposed water in the atmosphere or by the atmosphere itself. This formation of nitrous acid is a wise provision by nature for the purification of the air we breathe; every one knows that the air is always pure and more healthy after a thunderstorm; the nitrous acid acts upon and decomposes the miasms with which it was previously impregnated.

Water is a transparent, colourless liquid, well known to all, and, therefore, requiring no further description of its form and appearance. It is a universal solvent of soluble matter, acting slowly upon some inorganic substances, and not at all upon others, unless assisted by another chemical agent. It is said by Canton to possess considerable electricity,—yielding, as he affirms, in a perceptible degree, to the pressure of air in the condensing machine. But may not this philosopher be mistaken? May not the effect of the pressure result from atmospheric air and carbonic acid contained in the water with which he experimented? Nothing appears to show that he employed distilled water; and all other waters, whether from rain, springs, or rivers, contain both of these gases. The action of some metals upon water is to decompose it rapidly, of others to decompose it slowly; and of others not to decompose it all. Thus, iron decomposes it rapidly and seizes its oxygen; copper and zinc decompose it more slowly, whilst gold does not act upon it at all. The activity of water in its action upon organic substances is moderate, pro-

ducing no violent and sudden changes. The results of its action are various and useful. This moderation is highly beneficial to the life of animals and plants, which a too great energy of action would destroy. Water is a component part of the blood, and of milk; and it is an indispensable agent in both the structures and the food of the body. In its capacity of solvent, it carries into the animal frame the salts necessary for the secretions of living animal matter. It serves as a vehicle for the exhalations of the lungs and skin; and it is mixed with all the animal excretions. It acts the same beneficial part for vegetable as for animal life, being the vehicle of vegetable excretions and products; and is also an agent in the structure of plants. By its assistance flint and potash find their way into the structure of wheaten straw; by its aid the various other salts necessary to the structure of plants are absorbed. In vegetable matter, starch exists in mechanical mixture with it, gum and sugar are held in solution by it. In grain, in the potato, in farinaceous plants, water exists in large proportions, as it does in every kind of fruit, and in every kind of wood, stalk, leaf. and flower. Water, in short, fertilises the surface of the earth; in its absence, no vegetation could occur, no living thing exist. All organised nature requires it to sustain organism and life. Inorganic nature cannot do without it. Few liquids are free from water. Most of the fixed mineral acids contain it more or less; and it is a constituent of alcohol, even of ether. Solids also contain it. There is no crystallization of salts which is not due to water; deprived of it, the crystals fall to powder. Water likewise exists in almost all our appliances in domestic life. Without it we could not manufacture soap, nor paper, nor cloth, nor linen, nor leather, nor felt, nor china, nor earthenware, nor hardware, nor a variety of other matters of indispensable utility. Without it we should have neither wine, nor beer, nor ale, nor cider; for when not used artificially, it exists naturally in the fruits employed to produce these beverages. Without it, we should often be suffocated; for it absorbs noxious gases, and many molecules of matter that would strangely affect the lungs of breathing creatures.

Water at ordinary temperatures remains a liquid; at 32° Fahrenheit it hardens into ice; at 212° Fahrenheit it is converted into steam or vapour, quite invisible when not condensed by a colder medium, but generally visible in ordinary domestic boilings, because condensed by the colder air into which it emerges from the pot or tea-kettle. Although the temperature of water from ice just melted be precisely the same as that of the ice itself, namely, 32°, an amount of 140° more of insensible or specific heat, not indicated by the thermometer, must have been absorbed by the water to maintain its liquid condition. If this heat could not be absorbed from the surrounding media, if the temperature of the air remained at 32°, no thaw could take place. Thus, a lump of ice at 22°, being 10° below the freezing point, placed in a room at the temperature of 50°, would require, to melt it, just fourteen times the number of minutes or hours that would raise it from 22° to 32°. If, for instance, ten minutes were occupied in bringing the lump of ice from 22° to 32°, two hours and twenty minutes would be required to melt it into water at 32°. Thus, 10° of heat having entered the ice in ten minutes, fourteen times that amount was necessary to liquify it without raising the temperature, and $14 \times 10 = 140$. Dr Black suspended, side by side, two glass globes, of the same dimensions and capacity, the one filled with water at 33°, the other with ice at 32°. In half an hour, the temperature of the water had increased to 40°; but ten hours and a half elapsed before the ice was melted and the temperature of the water resulting from it raised to 40°. Hence, if, in half an hour, the water was heated to 40°, and it required twenty one half-hours to heat the ice to the same temperature, the corollary deducible is that 7° of heat entered into the globes every half-hour. Thus, $7 \times 21 = 147$, from which we must subtract the 7° which the water reached above 33° Therefore, $7 \times 21 = 147 - 7 = 140°$. Again, if a pound of ice pounded, at 32°, be mixed with a pound of water at 172°, the ice is immediately melted, and the result is two pounds of water at only 32°. Therefore, 140° have disappeared during the melting, being the exact quantity absorbed by the melted ice at the expense of the heated water. If this absorption of heat had not taken place, the result would have been two pounds of water at a mean temperature of 102°. These facts explain the cause of the slowness with which the ice and snow melt when a thaw succeeds an intense frost. Days and even weeks sometimes intervene before the whole is liquified. The same facts also account for the chilliness of the air during a thaw; the specific heat absorbed by the water from the melting ice is taken from the atmosphere at the expense of its *sensible* temperature, to become latent or specific; and therefore the air feels more cold and raw than before the thaw commenced.

If water, in the process of cooling and solidifying, followed the ordinary laws of heat and expansion of liquids, its surface would contract, and become heavy in proportion to its contraction, and sink beneath the other layers; and these would successively replace it, so that the whole body would become gradually cooled to the freezing point, the lower stratum being always the coldest, and therefore the first to solidify or freeze. But, were this really the case, the bottom or under surface of the fluid would freeze first, which is contrary to fact; also, every river would become so full of ice, each of its banks, as well as every sea-coast in our latitudes, would become so ice-bound, that the strongest heat of summer

would not suffice to thaw them; and perpetual snow and ice, as upon Alpine summits, would cover and render uninhabitable those beautiful countries in which organic matter flourishes, in which vegetation spreads its luxuriant fruitfulness, in which living creatures not only breathe and exist, but enjoy the manifold blessings of physical comfort which God's Providence has specially created for their benefit. But the Creator has beautifully contrived to obviate this. Everybody knows that water always freezes at that part nearest to the atmosphere, that is to say, at the top or upper surface, and not at the bottom or under surface. This, however, appears to be contradictory to the general laws of heat and expansion; and so it is;—for the Maker of all things has ordained an especial exception to these laws in regard to water, so useful to his organic world, so necessary to the comforts, nay, the very existence of animal life. In our temperate latitudes we are not ice-bound; our rivers never possess more ice than will thaw in a week or ten days under the temperature of spring. Water does not contract by the loss of heat, after it has reached a certain temperature; on the contrary, it expands. Water contracts until it reaches 39½°, being 7½° above the freezing point; it then begins to expand in proportion as its temperature descends to that point. The colder water consequently rises to the surface. Thus, when the liquid has reached 32°, the warmest layer of the fluid is at the bottom, the coldest at the surface. Here, then, the freezing begins, and the ice increases in thickness as the upper ice becomes colder. But it never descends to the bottom of rivers; otherwise the population of our waters, so useful to us as food, and for many other purposes, would be wholly destroyed. There is another fact: water, in the act of solidifying, expands still further; and so powerful is this expansion, that it will cleave the hardest and most tenacious rocks. No metal can resist its power, as may be exemplified by filling the barrel of a gun with water, sealing it hermetically, and placing it in a situation for the water to freeze. The expansion will burst the barrel; so it would a cannon under similar circumstances. See the articles Freezing and Frost.

Under ordinary atmospheric pressure computed from the level of the sea, pure water boils at 212°; though waters containing matters in solution, as all our domestic waters do, require a higher temperature to boil. Every 500 feet of elevation diminishes the pressure so much, that water will boil at one degree less; so that on the Peak of Teneriffe, it boils at 192°, and on the highest part of the Himalaya range where human creatures can breathe, at 170°. In a vacuum, water will boil at a much lower temperature than this; nay, it will actually boil on the application of cold, as the following pretty experiment will show. Let a clean Florence oil-flask be half filled with water; place it over a lamp until the water boils; remove the flask from the fire and cork it while still full of steam. The water has now ceased to boil; but if the flask be plunged into a pail of cold water, the boiling will recommence. The reason is obvious. The steam generated by the boiling alone occupies the space in the flask above the water, the atmospheric air being expelled by the heat; and the flask being corked, the steam remains where it was; but on plunging the flask into cold water, the steam is condensed by the cold, and falls in the form of water into the liquid beneath it, leaving a vacuum above, when the boiling immediately recommences.—When a vessel containing water is placed over a fire, a hissing sound is soon heard as the fluid increases in temperature. This is caused by the vibrations arising from the vaporisation of the particles of liquid in contact with the bottom of the vessel, which being nearest to the fire is, of course, the first part heated. These particles vaporise and again become condensed as they rise, until sufficient heat is imparted to the mass of the liquid. As this heats, the sound becomes louder, until ebullition begins and steam is rapidly evolved. The temperature is now stationary; it never rises above the boiling point, nor does the steam formed acquire a higher temperature. It may be remarked, however, that under considerable pressure water may be heated to a red heat, that is to say, to a heat which cannot exist without light, about 800° Fahrenheit; but the moment the pressure is removed and the liquid open to the air, the temperature suddenly jumps down to 212°, and steam violently escapes. When water is thus heated, the vessel containing it becomes red-hot, the water itself being so; and this state of things no doubt sometimes exists, when not suspected, in steam-engine boilers, and in the hot-water apparatus for warming churches, dwelling-houses, and manufactories, and may there give rise to very serious accidents. See the article Boiling.

Though steam is generated from water at a temperature of 212°, yet this vapour requires a thousand degrees more of heat to assume the gaseous condition. This fact is shown by the following experiment, which we take from Professor Donovan's Elements of Chemistry:—"If a pound of steam at 212° be received into 5·56 pounds of water at 32°, the former will be condensed into water; and the whole, amounting to 6·56 pounds of water, will have the temperature of 212°. The temperature of the steam, now water, has not been reduced, yet 5·56 pounds of water have been raised from 32° to 212°, that is 180° for each pound, or 1000° (180° + 5·56) in all. Had a pound of water at 212°, instead of a pound of steam at 212°, been mixed with the 5·56 pounds of water at 32°, the resulting temperature would only have been 64° instead of 212°. Hence the number of degrees of heat which steam at 212° contains in a latent state, and which does not elevate its temperature, is

one thousand." Steam, of late years, has been employed not only in the principal mechanical arts, but in the wonderful appliances of steam navigation aad railway travelling; in many kinds of manufacture, its substitution for boiling water has produced a perfection of process quite unattainable without its aid; and even in the culinary department, it has been employed during more than half a century with very great advantage in schools and public institutions, where it obviates a considerable expenditure of fuel which would arise from water-cooking. A range of tin vessels, each containing its separate articles to be cooked, are made to communicate with each other, and the last with a boiler containing water; and as soon as the water commences ebullition, the steam enters the first vessel, then the second, and so on to the last, which has just as good a share of heat as the first. Proper precautions are taken for the escape of the steam, which, if confined, might cause an explosion. In preparing food upon an extensive scale for cattle, and hogs, and for the dog-kennel, steam is most valuable, being a much more perfect as well as a more economical agent. See the articles STEAM and STEAMING-APPARATUS. — In heating apartments, especially in large manufactories, steam is superior to every other agent, as regards both economy and the production of an equable and permanent temperature, attended by comfort, cleanliness, and safety. We are told by Dr. Ure, that a single cubic foot of boiler will heat 2,000 cubic feet of space in a cotton-mill, having an average temperature of from 70 to 80 degrees. Again, one square foot surface of steam-pipe is sufficient to warm 200 cubic feet of space. Thus, a pipe containing little more than 27 square feet of surface would warm a drawing-room 24 feet by 20, and 12 feet high. But as the heat from the pipe is communicated principally by radiation, the surface of the latter should be kept black.—Drying operations in calico manufactories have for many years been effected by steam; and the same agent is employed in the drying of gunpowder. In the rooms where steam-drying takes place, the workpeople remain particularly healthy, which is far from being the case where stoves are used for the drying process. The heating of baths by steam is also very advantageous, especially in public establishments. One gallon of steam will heat 18 gallons of water to 100 degrees,—the steam being driven into the water through a pipe; and this heating is almost instantaneous. In private families, a steam-pipe, with a stop-cock, might communicate from the boiler of the kitchen-range to the bathing room.

Besides the vapour thus generated by the temperature of boiling water, there is another kind of vapour of water in constant progress of vaporisation, which, however, is slow and imperceptible, but upon which depends the very life of the organic world. This is called evaporation. It takes place at all temperatures, from the burning heat of the torrid zone to the temperature of a Siberian winter. The atmosphere has an insatiable thirst for moisture; and takes it from all sources. Evaporation into it is therefore always going on from the surface of the ocean, from that of lakes and rivers, from that of every body of water, however minute, and from the surface of the earth, from the surface of plants, and even from the bodies of living animals. Though more powerful in a warm temperature, it is still in activity, greater or less, at all seasons and in all climates; and if condensed vapour be seen rising from the surface of a pond during the evening in autumn, the same kind of vapour, though in less quantity, will arise when the weather is very cold—nay, even should the surface of the pond be frozen. Within the tropics, the amount of evaporation is enormous; and even the waters of the Mediterranean are supposed, every hot summer's day, to diminish by evaporation to the amount of five hundred millions of tons; and they make good this loss partly by the tribute of rivers, and partly by influx from the Atlantic. The leaves, stems, and fruits of plants—nay, their very seeds—the respiration, perspiration, and excretion of animal life, all supply water to the air; and so does even the humus or vegetable soil of the earth. This universal evaporation accounts for the drying of anything that is wet; and it dries sooner before a fire than at ordinary temperatures, because the higher the temperature, the more rapid the evaporation. If no evaporation took place, we should be unable to dry anything; our clothes, our houses, our articles of manufacture or raw materials, once wetted, would ever remain so till the end of time. Evaporation at equal temperatures is much more rapid during wind than when the air is calm,—a fact exemplified by every washerwoman, who will certify that a strong breeze greatly hastens the drying of her clothes. If the evaporation from the ocean be prodigious, that from the surface of the land is not less so. Bishop Watson, in his Chemical Essays, states that, during a summer's day in Great Britain, the evaporation from an acre of mown meadow-land, after the removal of the hay, amounts to 1,600 gallons,—a conclusion to which he came as the result of a series of experiments carefully conducted by himself.—But what is the use of this enormous evaporation, of this unquenchable thirst of the air surrounding our globe? It is another beautiful provision of the Almighty Creator for the wants of organic nature; it is the life-spring of the animated creation. We have explained the absorption of specific heat by steam as it is generated from boiling water. A similar absorption of specific heat takes place during evaporation, otherwise there would be no evaporation at all, and the water at present evaporated would retain its liquid condition. This absorption of specific heat, being made at the expense of the surrounding media, causes a sensible diminution of tem-

perature. Thus, the heated air is cooled by evaporation from the earth, without which all tropical regions would be uninhabitable by man, and even our temperate latitudes so hot in summer as to cause death. When the body is overheated, nature has provided a flow of aqueous perspiration, which appears upon the skin, and by its evaporation keeps the body at a proper temperature. Anything impeding this perspiration causes disease and death. All our supplies of fresh water also come from the atmosphere as a result of this general evaporation, which is a modifier of heat, and the source of the freshness and fertility that make the surface of the earth so beautiful to look upon, when teeming with luxuriant verdure, and with grain and fruit for the use of living creatures. When the air becomes surcharged with moisture, or when a change of temperature or a change of electrical action takes place, the vapour is condensed and falls to the earth in refreshing showers, or in the form of snow or hail. Snow is the vapour frozen ere it has had time to condense into rain-drops; hail is formed by the freezing of the drops themselves; and all three have their several uses in the economy of nature. The water which thus falls, charged with some matters contained in the atmosphere, has several functions to perform. The greater portion of it sinks into the earth, forming springs, sources of rivers, or remaining hidden in great reservoirs till called forth by the energy of man; another portion is immediately evaporated back again into the atmosphere; and a third portion is decomposed by the plants upon which it falls, and which, assimilating its hydrogen for their nourishment, give out the oxygen to the air,—and this last explains why the proximity of vegetation is so refreshing immediately after a heavy shower, the portion of oxygen being increased without having yet had time to be diffused. See the articles Evaporation, Atmosphere, Cloud, and Rain.

Rain water, though freer from foreign substances than any water which has flowed in contact with the solid earth, contains atmospheric air, carbonic acid, ammonia, and sometimes other gases; all of which it absorbed during its formation in the clouds or during its descent thence to the earth; and all the ammonia—but very particularly in the first rain which falls after a drought—is distinctly charged with the offensive odour of animal perspiration, excrements, and putrefaction. See the article Ammonia. Though in London rain-water is seldom applied to domestic purposes, as the Thames supplies the wants of the laundress, and no contrivances are generally used for its preservation, yet in many provincial cities and towns, and in the rural districts, it is carefully preserved for the purposes of the wash-house; and where no other soft water is to be obtained, rain-water forms a very important article of domestic use and consumption. But it is unfit to drink; though in some countries, where none other is to be had, it is preserved in tanks, and applied to the purposes for which hard water is preferable. Rain-water, however carefully filtered, is mawkish and unpleasant to the taste, and, if not actually unwholesome, is very inferior, as a solvent in the stomach and for the supply of the human frame, to water from springs and fountains, or even to that from rivers and lakes. Filtering does not divest it of any matter held in chemical solution; and those who drink rain-water must take it with the unpleasant accompaniments which are combined with its ammonia.

Water derived from rivers and lakes is sometimes as soft as rain-water, and sometimes as strongly impregnated with lime and other compounds as water from hard springs, or from those termed 'mineral springs.' What it carries with it depends entirely upon the soil through which it runs. But it requires a number of years before the water from heaven can, by contact with the soil, extract an alkaline salt from it. This is the reason why rivers and lakes, especially when fed by heavy rains, or periodical meltings of snow and ice, have their waters soft; and these waters are sometimes freed from the ammonia derived from the atmosphere, sometimes strongly impregnated with it. When at hand, they serve for the same domestic purposes as rain, and are used besides as a beverage for men and cattle. But such waters, especially in rich valleys, are frequently charged with matters which render them unwholesome unless carefully filtered. They carry with them, in mechanical mixture, not only the alluvium which renders them turbid, but much putrid animal and vegetable matter. In addition to this, in large cities, especially in those where manufactures exist, and through or near which a river flows, this latter receives, in addition, various very unwholesome compounds, besides the worst filth and soil of the place, from which no filtering will free the water. No attention is ever paid to keep such rivers from pollution, and the inhabitants are not unfrequently compelled to draw water for their tea and other purposes from a river into which run the drains and sewers of the town. The soft water of rivers, springs, and brooks, not far from the sea, generally holds in solution a minute quantity of common salt. Unless it run over a rocky bed, the water of rivers requires filtering before it is fit for human drinking. Many of the mountain torrents in Switzerland are said to be impregnated with salts which, when the water holding them in solution is applied to domestic use, produce that deformity in the throat known by the name of goîtres,—a complaint common in mountainous districts, even in England. The soft water of rivers, lakes, ponds, or fountains is generally preferred for the preparation of vegetable infusions and decoctions, and of vegetable extracts. It is stated to be preferable likewise for the brewing of ale, porter, and beer; though

we do not quite assent to this proposition. Many of the beverages derive the peculiar qualities for which they are celebrated, from the salts held in solution by the waters employed in their preparation. The famous Burton ale receives a distinguishing flavour from the liquid used in brewing it, which liquid in its natural condition, that is to say, in the state in which it is drawn by the brewers from its natural reservoir, is said to hold in solution small quantities of the sulphates of iron and lime, and of nitrate of potash. It has been affirmed, and was once generally believed, that the soft water taken from muddy ditches and stagnant pools, teeming with both animal and vegetable matter, was preferable for the purposes of brewing, to the harder waters of rivers, wells, or fountains; and many infatuated individuals, misled, doubtless, by their blind confidence in the asseverations of ignorant men who hire themselves to brew in families, are persuaded, even now, that the decomposed matter, mixed with this water, is actually advantageous to the vinous fermentation of the ale. For our own part, we believe that both hard water from wells and soft water from rivers, provided neither contains any matters in mechanical mixture which will putrefy, will dissolve all the fermentable matter of the malt, when the mashing is properly done; and this is all that is required. It has long been a vulgar error, especially in the provinces, that no good porter can be produced anywhere out of London; and that the reason of this is the peculiar property of the Thames water, with which alone good porter can be brewed,—no other water being capable of yielding that beverage in perfection. The cause assigned is that the Thames is charged with much fermentable matter, which hastens the action of the brewers' yeast; but they have overlooked the fact that this matter is a strong putrefactive ferment. Without having recourse to theory or hypothesis to ascertain why the water of the Thames should alone be possessed of the property of producing good porter, we must first inquire whether such be really the fact; and this question will be answered negatively, for not one of the public brewers of porter in London ever uses the Thames water in his brewery,—each has, on his premises, a well from which he draws all the water that enters into the composition of his porter. The water of the Thames is certainly the best in the world for the use of ships sailing on long voyages. When pure, it is of a rather soft taste, being not greatly charged with soluble matters. But it holds in mechanical mixture substances which impart to it a very singular property. After it has been at sea two or three days, it commences a very active putrid fermentation, during which much carbonic acid and some carburetted hydrogen are given out, together with a most offensive odour. By the time a week has expired, this fermentation begins to subside; all foreign matter contained in the liquid falls gradually to the bottom of the cask or tank, where it becomes a tenacious mass; whilst pure water, beautifully limpid and free from taint, lies above it. This water will keep more than a year; and when passed either through a filter or a common dripstone, is the finest and purest water that can be obtained for human drinking; it is brisk and gratifying to the palate, which shows that it is well charged with atmospheric air and carbonic acid. We have already observed, that soft water is the preferable for vegetable infusions. That of tea, so much used in this country, is often defective; and the grocer is unjustly accused of having sold a bad article, from the mere fact that the water employed is very hard. Moderately hard water will make tolerably good tea; but in water with excess of hardness, the leaf will not infuse, unless an alkali be employed to diminish this hardness by precipitating a portion of the salt that constitutes it. This is the reason why, where very hard water prevails, a small quantity of soda is often put into the teapot.

Generally speaking, calcareous waters moderately charged with carbonate of lime, are the most wholesome for drinking. It is a vulgar error to suppose, because a deposit of a hard concrete salt takes place round the inner surface and over the bottom of the teakettle, that it is much more wholesome to drink water previously boiled and cooled. Such water is decidedly unwholesome; the boiling temperature deprives it of both its atmospheric air and its carbonic acid, and the water so treated requires long exposure to the atmosphere ere it absorb sufficient of these matters to be again drinkable. It is the heat which, by depriving the water of its carbonic acid, makes the lime precipitate in the form of carbonate of lime. This compound is insoluble; for everybody knows that neither chalk nor marble, nor any kind of limestone, will dissolve in water. Yet water, in passing through or over beds of chalk or other carbonate of lime, generally carries away with it a small portion of that substance; and this it is enabled to do by means of the free carbonic acid which it contains, and which, uniting with the insoluble carbonate, forms a soluble super-carbonate. But the proportion of this salt, as also that of other saline substances, is exceedingly variable in different kinds and specimens of drinkable water. For example 100,000 parts of the water of the Seine above Paris contain 11·3 of carbonate of lime, 0·4 of carbonate of magnesia, 0·5 of silica, 3·6 of gypsum, 0·6 of Epsom salt, 1·0 of chloride of calcium, 0·8 of chloride of magnesium, and traces of nitrates and of organic matter; 100,000 parts of the water of the Marne contain 10·5 of carbonate of lime, 0·9 of carbonate of magnesia, 0·6 of silica, 3·1 of gypsum, 1·2 of Epsom salt, 1·7 of chloride of magnesium, and traces of organic matter; 100,000 parts of the

water of the Ourcq at St. Denis contain 17·5 of carbonate of lime, 2·0 of carbonate of magnesia, 2·0 of silica, 15·3 of gypsum, 7·0 of Epsom salt, 4·0 of chloride of magnesium, and traces of common salt and of organic matter; 100,000 parts of the water of the Yonne at Avallon contain 4·3 of carbonate of lime, 1·9 of silica, traces of gypsum, 1·5 of chloride of calcium, and traces of common salt and organic matter; 100,000 parts of the water of the Benvronne contain 25·7 per cent. of carbonate of lime, 20·3 of gypsum, and 8·5 of chloride of calcium; 100,000 parts of the water of the Thérouenne contain 26·2 of carbonate of lime, 2·0 of gypsum, and 3·6 of chloride of calcium; 100,000 parts of the water of the Gergogne contain 18·0 of carbonate of lime, 1·5 of gypsum, 1·5 of chloride of calcium, and 0·9 of common salt; 100,000 parts of the water of the Bièvre near Paris contain 13·6 of carbonate of lime, 25·1 of gypsum, 10·9 of chloride of calcium, and 1·2 of common salt; 100,000 parts of the water of the Arcueil contain 16·9 of carbonate of lime, 16·9 of gypsum, 11·0 of chloride of calcium, and 1·9 of common salt; 100,000 parts of the water of the spring of Roye at Lyons, contain 23·8 of carbonate of lime, traces of silica, 1·4 of gypsum, 1·2 of common salt, and traces of nitrates and organic matter; 100,000 parts of the water of the Fountain Spring at Lyons contain 23·4 of carbonate of lime, traces of silica, 1·7 of gypsum, 1·3 of chloride of calcium, traces of chloride of magnesium, 0·2 of common salt, and traces of organic matter; 100,000 parts of the water of the Rhone at Lyons, in July, contain 10·0 of carbonate of lime, traces of silica, 0·6 of gypsum, and traces of Epsom salt, of chloride of calcium, of chloride of magnesium, of common salt, and of organic matter; 100,000 parts of the water of the Rhone at Lyons, in February, contain 15·0 of carbonate of lime, 2·0 of gypsum, 0·7 of Epsom salt, 0·7 of chloride of calcium, and traces of nitrate of lime, and of organic matter; 100,000 parts of the water of the spring of the Garden of Plants at Lyons contain 27·0 of carbonate of lime, 25·2 of gypsum, 16·8 of carbonate of calcium, 1·6 of chloride of magnesium, 12·6 of common salt, 7·6 of nitrates, and traces of organic matter; 100,000 parts of the water of the Lake of Geneva contain 7·2 of carbonate of lime, 0·7 of carbonate of magnesia, 0·1 of silica, 2·6 of gypsum, 3·1 of Epsom salt, 0·9 of chloride of magnesium, and 0·6 of organic matter; 100,000 parts of the water of the Arve, in August, contain 5·2 of carbonate of lime, 0·4 of carbonate of magnesia, 0·1 of silica, 3·2 of gypsum, 2·9 of Epsom salt, 0·7 of chloride of magnesium, and 0·3 of organic matter; 100,000 parts of the water of the Arve, in February, contain 8·3 of carbonate of lime, 1·2 of carbonate of magnesia, 0·2 of silica, 6·5 of gypsum, 6·2 of Epsom salt, 1·5 of chloride of magnesium, and 0·4 of organic matter; 100,000 parts of the water of the Loire near Orleans contain 1·7 of carbonate of lime, 5·1 of chloride of calcium, and traces of common salt; 100,000 parts of the water of the Loiret contain 11·9 of carbonate of lime, 3·8 of gypsum, 10·2 of chloride of calcium, and 2·5 of common salt; and 100,000 parts of the water of the Artesian Well at Grenelle, near Paris, contain 6·8 of carbonate of lime, 1·42 of carbonate of magnesia, 2·90 of bicarbonate of potash, 1·2 of sulphate of potash, 1·09 of chloride of potassium, 0·57 of silica, and 0·24 of nitrogenous organic matter. All these are drinkable waters, and were analysed by some of the most distinguished chemists of Continental Europe,—Bouchardat, Boussingault, Dupasquier, Tingry, Guindant, and Payen; and, of course, the drinkable waters of the streams and wells of Britain differ as widely as they in both the kinds and the proportions of their saline impregnations.

Water which is quite or even grossly unsuitable to be drunk by human beings may be statedly drunk without any injury, or even with very salubrious effects, by horses and cattle. See the articles Horse and Pond. Even water so highly impregnated with saline matter as to contain upwards of one ounce of it in every four gallons may be constantly drunk by horses with perfect safety. A specimen not long ago analysed by Professor Johnston contained in every gallon 78·42 grains of common salt with a little chloride of potassium, 4·18 of chloride of calcium, 3·53 of chloride of magnesium, 25·71 of gypsum, 15·44 of carbonate of lime, 12·88 of carbonate of magnesia, 0·48 of carbonate of iron, and 1·0 of silicate of soda; and some horses who had statedly drunk this water unexpectedly died, and were conjectured to have been injured by it, but proved on enquiry to have fallen victims, quite independently of it, to an epizootic pleuro-pneumonia. In all ordinary watering of horses and cattle, however, some streams and ponds and springs may soon be observed by careful, keen-eyed practical men to comport better with health than others; and unless they exist under circumstances which would involve the constant use of them in too much cost or trouble, such ought, of course, to be always preferred. Yet saline ingredients which are neither useful nor hurtful to cattle, but which constitute direct and valuable food of cultivated plants, or excessive quantities of such as are useful to cattle and at the same time constitute food of plants, exist so largely in some waters as to render them highly preferable in the watering of cattle for sake of the ulterior enrichment of the farm-yard manure. "The waters which serve as drink to the cattle of a farm," remarks Boussingault, "introduce into the dung-heap all the matters which are dissolved or held in suspension. At Bechelbronn, for example, I find that more than 2 cwts. of alkaline salts get into the dung in this way every year. When a farmer has the choice of several waters for giving his cattle or irrigating his meadows, he will do well to select that which is richest in alkaline salts, and

still good to drink. In the steppes of America, it is astonishing with what discernment the cattle choose waters for allaying their thirst, containing minute quantities of sulphate of soda or common salt."

Waters suitable for irrigation are vastly more variable in the kinds, combinations, and amount of their impregnations, than waters suitable for drinking; and though they have already been discussed in the article IRRIGATION, the following notes upon them, in a recent report of the Scottish Agricultural Association drawn up by Professor Johnston, may here be introduced as valuable:—"Our present knowledge of the composition and wants of the growing plant, forbids us to ascribe to its lime alone the whole of the chemical influence which a water may exercise when employed for irrigation. Plants require common salt, and all natural waters contain it; they require sulphur, and in nearly all natural waters it is present; they require also magnesia and phosphorus and iron, and animal or vegetable matter, and nearly all waters contain these, though often in quantities too minute to be readily detected. Each of these substances, therefore, when present in water, may have its influence in producing the results which are brought about by its use in irrigation. The precise degree of merit to be ascribed to each, will depend upon the proportion in which it exists in the water and in the soil, and upon the kind of plant or herbage cultivated. As a general rule, it may be stated that the value of water for the purposes of the irrigator, depends first upon the quantity, and second upon the quality, of the solid matter it contains. That which contains most solid matter, other things being equal, should be the most valuable. To this, however, there are exceptions, as in the case of waters which, like those of the sea, or of salt springs, contain so much saline matter as in weather of ordinary drought to injure and sometimes actually destroy the herbage; or of spring waters which contain so much lime as to form a deposit or incrustation on the leaves of plants. It will also be understood, that, generally speaking, though a water contain a larger proportion of solid matter, yet if this solid matter consist almost entirely of one substance, it may be less valuable than a water which contains a smaller quantity of solid matter on the whole, but in which a number of important ingredients occur in proportions more nearly resembling those in which they are required by plants. It is in especial reference to such points as these that a careful analysis of waters which have been successfully employed for irrigation upon our soils and in our climate, is both practically and theoretically important. The four following analyses exhibit the composition of waters which are sufficiently abundant to be used for irrigation, but which are not, so far as I know, any where in their course employed for this purpose.

	River Ale.	River Eye.	Biglaw burn.	River Wear.
Organic matter	1·75	1·64	2·58	0·92
Potash in the state of sulphate	1·68	0·80	0·72	1·50
Soda and chlorides		0·44	1·94	
Gypsum (sulphate of lime)	0·64	1·46	2·94	0·88
Carbonate of lime	5·28	3·48	7·32	7·92
Carbonate of magnesia	1·00	1·24	3·64	2·04
Chloride of magnesium	1·82	0·80	1·25	—
Oxide of iron	0·56	0·48	0·60	0·56
Sulphuric acid	1·44	0·98	1·80	0·96
Chlorine	0·36	0·70	1·65	1·10
Silica	0·24	0·08	0·32	1·20
	14·77	12·10	24·76	17·08

These waters are so far fitted for irrigation, that they all contain nearly every thing which the plant requires. That from Biglaw burn, however, both by the quantity and quality of the ingredients it holds in solution, is most likely to administer to the growth of plants, and to supply the natural or acquired deficiencies of any soil over which it may be made to flow."

Some of the chief uses of water to vegetation, irrespective of the nourishment which it contributes in the form of the salts and the gases held in solution by it, are noticed in the articles GERMINATION, ABSORPTION IN PLANTS, DEW, AGRICULTURAL CHEMISTRY, and LIQUID MANURE; and some of the many chemical actions of water upon the constituents and the temperature of the soil, in their connexion with vegetation, are noticed in the article DRAINING. Water not only brings to plants the constituents of their food which it gathers and absorbs during its descent through the atmosphere, and during its progress on the surface and through the strata of the earth, but also acts as the solvent and the vehicle of all the constituents of their food obtained from manure and from the solid ingredients of the soil; and it constitutes by far the bulkier portion, not only of the sap which ascends within them from the roots to the leaves, but also of the cambium which descends after the processes of evaporation and elaboration to form all their secretions and excretions,—and even constitutes a main portion of their secreted juices, and a very considerable portion of their cellular and vascular substance or of their somewhat solid matter. See the articles SOIL, MANURE, SAP, CAMBIUM, and ORGANIC CHEMISTRY. The chemical actions of water, in their joint simplicity and power, are probably nowhere more remarkable than within the organisms of plants; and they no doubt play both a conspicuous and a manifold part in the multitudes of decompositions and recombinations which characterise vegetable organic chemistry, and particularly in those which deal with gases, and which reduce the elements of aeriform substances into liquid and solid secretions. Water, when deprived of all its air by ebullition, has the power of absorbing in every 100 cubic inches of its bulk, under the mean temperature and pressure of the atmosphere, about 100 cubic inches of sulphuretted hydrogen, about 100 of carbonic acid, about 76 or upward of nitrous oxide, about 12½ of olefiant gas, about 3·7 of oxygen, and

about 1·56 of respectively carbonic oxide, nitrogen, and hydrogen; so that, in all the approaches of water to plants, whether through the air or along the surface of the earth, or through the interior of the soil, it acts as a mighty, greedy, and general forager on their behalf, and constantly comes laden to them with a variety of the most enriching spoils. In its capacity of general menstruum, general solvent, and grand constituent of juices, also, it is a mighty and essential modifier of all other natural agencies upon plants, lubricating all the organic energies, sustaining all the absorptive, inhalent, and exhalent functions, assisting every internal act and process of chemical transmutation, attempering the outward play of light and heat and weather, and resisting all mischievous effect from excess of calorific, absorbing, or caustic agencies. The reasons, therefore, are strong and many why field plants are injured or destroyed by droughts, and why garden ones are benefitted by artificial waterings. Yet the diffusion of water as vapour through the atmosphere when it loses its liquidity and rises out of the soil,—the accumulation and abundance of it in the former state proportionately to the decrease and scarcity of it in the latter,—and the adaptation of it as a vapour, together with all the gases which it has absorbed, to be bibulously inhaled through the stomata of plants,—are to the full as wonderful as any of its other properties, and beautifully supplement the amazing powers with which the Creator has endowed it for supporting vegetable existence. "The quantity of water which exists in air as vapour," remarks Sir Humphrey Davy, "varies with the temperature; in proportion as the weather is hotter, the quantity is greater. The leaves of living plants appear to act upon the vapour in its elastic form and to absorb it. Some vegetables increase in weight from this cause, when suspended in the atmosphere and unconnected with the soil; such are the house-leek, and different species of the aloe. In very intense heats, and when the soil is dry, the life of plants seems to be preserved by the absorbent power of their leaves; and it is a beautiful circumstance in the economy of nature, that aqueous vapour is most abundant in the atmosphere when it is most needed for the purposes of life, and that when other sources of its supply are cut off, this is most copious."

The command of a sufficient supply of water for all the uses of the farmery and of live stock, is essential to agriculture, and was formerly a great desideratum throughout some extensive districts in Britain. In the low tracts of Lincolnshire, water free from brackishness and perfectly fit for drinking is so scarce that carts are sent for it to the distance of several miles,—sometimes even to the distance of 16 or 17 miles; in the wolds of Yorkshire, previous to the invention of the improved mode of making artificial ponds, instances were frequent of numbers of animals perishing from thirst; and in Hampshire, from the long continuance of dry weather during the autumnal months, the wells became so exhausted, that great labour and expense were incurred in supplying the family and stock, by means of water-carts. To avoid the risk of such serious misfortunes, it was anciently the practice, for the conveniency of having water, to erect farm-buildings in low grounds, near brooks or rivers; but on this plan the house became damp, the grain, from the moisture of the atmosphere, was frequently injured, and, from the vicinity of the water, accidents of various descriptions frequently occurred. When the advantages, therefore, of having a house and offices in the centre of the farm, and rather on an elevated situation, came to be generally understood and admitted, methods were adopted for obtaining supplies of water from the roofs of the farm-buildings, from natural springs, and from wells, artificial ponds, and artificial rills. The buildings and yards of a farm are supposed to receive rain sufficient, if duly collected, to supply both the family and the cattle of the place for a considerable part of the year; and ponds, where necessary, may be made in any situation, at a very small expense, for the remainder. See the article Tank. Where natural springs occur, they will generally furnish a sufficient supply for family use; but they are seldom adequate to the necessities of a great farming establishment. See the article Spring. In Middlesex and Surrey, the farmers have dug to the depth of from 100 to upwards of 560 feet, before they could procure water; in Essex they have been obliged to go as deep as 500 feet to obtain water of a good quality; and, in Hampshire, they have likewise dug from 300 to 400 feet in depth, through dry, cracked, or fissured chalk rock. See the articles Well and Artesian Well. In several parts of England, as in Hampshire, in Lincolnshire, and in Norfolk, artificial ponds were long ago formed with varied skill and success. In Gloucestershire, they were made either of a square or of a circular shape, and generally so situated as to furnish a supply to four fields. Three layers of clay, free from the smallest stone or gravel, were so worked in as to form an impenetrable cement; and the whole was afterwards covered with sand and finished with pavement. In Derbyshire, artificial 'meers,' or cattle ponds, are made in dry rocky pastures, with great success. Having selected a low situation for the purpose, they deepen it ten or twenty yards across, and spread over the whole excavation a layer, about five inches thick, of refuse slaked lime and coal cinders; they then spread, trample, and ram down, a stratum of well-tempered clay, about four inches thick; and upon this they place a second bed of clay, in a similar manner, of the same thickness; the whole of the bottom and edges of the meer is then paved with rubble stones; and small rubble stones, several inches thick, are spread upon

the pavement. Other and newer methods are noticed in the article Pond. In the North Riding of Yorkshire, there is a tract, extending for many miles, entirely destitute of water, except what flows along the bottoms of the deep valleys by which it is intersected, and little relief could consequently be afforded by streams thus distantly and inconveniently situated to the inhabitants of the uplands and their cattle. About the year 1770, a person of the name of Ford devised a method of watering this district, by means of rills brought from the springs that break out at the foot of the still loftier moorland hills that run parallel to and northward of this tract, in some instances at the distance of about ten miles. These springs he collected into one channel, which he carried in a winding direction about the intervening tract, according to its level, and along the sides of the valleys, until he gained the summit of the arid country which he wished to supply with water; and when this was accomplished, the water was easily conveyed to the places desired, and also to the ponds in all the fields, over a considerable tract of ground. The plan of thus watering a dry upland country has much merit. It is not expensive, the original charge rarely exceeding £100 per rill, while it affords a most important accommodation to the occupier, and greatly enhances the value of the property. Though not generally applicable, this plan might certainly be adopted, with great advantage, in some other situations. A supply of water is also an object of great importance in every field where pasturage is intended. With that view, if there happens to be a small rivulet in the neighbourhood of the lands, it may often be distributed in branches, so as to water many fields. Springs, or the collected discharges from drains, may also be applied to the same purpose. All land used for grazing requires to be constantly well supplied with water. In conducting water through fields, it is of material importance to take care that the slopes be gentle, and not more than sufficient for easy transmission; as, when water is conveyed down fence ditches, or open conduits of considerable declivity, it is too apt to do injury in its progress by washing away the sides of its channels. Sometimes water is collected in a field, not only for the use of the animals pastured there, but also to be afterwards diverted for other uses, as for threshing and other mills, for irrigation, for ponds, for bleaching, and similar purposes. To accomplish these objects, and at the same time to prevent injury from this element, the drains, conduits, sluices, bridges, gates, and fence-ditches, require to be designed with skill, and constructed with scientific attention.

WATER ALOE. See Water Soldier.

WATER CALTROPS. See Caltrops (Water).

WATER CART. See Cart and Liquid Manure Cart.

WATER CHICKWEED. See Montia.

WATER COWBANE. See Cowbane.

WATER CRESS,—botanically *Nasturtium Officinale*. An indigenous, culinary, aquatic plant, of the cruciferous order. It inhabits rills and ditches in most parts of Britain. The roots are perennial, and comprise a great many long fibres, and attach themselves to the mud at the bottom of the water; several stems arise from each root or set of roots, and have a height of about 18 inches, and are hollow, channelled, and leafy, and divide at the top each into two or three branches; the leaves are pinnate, and have each 5 or 6 pairs of leaflets and a terminating odd one; the leaflets are roundish or almost heart-shaped, and stand almost alternately along the midrib; the flowers come out in loose spikes at the ends of the branches, and are small and white, and bloom from May till July; and the pods have a tapering form, and are full of small brown seeds. This plant came into pretty high favour about a century ago as a spring salad; and it soon obtained preference to all other spring salads on account of its agreeable warm bitter taste, and for sake of its purifying, antiscorbutic and diuretic properties; and was greeedily gathered in all its natural habitats within some miles of London for the supply of the London market; and eventually came to be an object of regular, peculiar, and somewhat extensive cultivation. The places most suitable for growing it are gently flowing rills, with a gravelly or chalky bottom, and with from 1½ inch to 4 or 5 inches depth of water; and if only muddy bottomed rills are available, the mud should be removed from them and gravel substituted. The plants are propagated by division of the root; and require to be cleaned, lifted, and replanted twice a-year. The plantings and removals should be done in successions during May and June for affording supplies of salad in August, and during September, October, and November for affording supplies in spring. The plants should be set in rows, commencing as near as possible to the sources of the stream; and the rows should be about 18 inches asunder in shallow rills, and from 18 inches to 7 feet in deeper ones. In every process of cleaning and renewal, all weeds, mud, and rubbish should be cleared away; and in the accompanying process of replanting, all the youngest and best-rooted cresses should be selected for use, and each returned into the stream and retained in its proper place with a stone; and during winter, crops in even the shallowest streams should be so managed in the cutting as to impede the current to a sufficient degree to maintain it at a depth of 4 or 5 inches. Gatherings from the plants should be done always by cutting, and never by breaking; and, in a favourable situation, with a good set of plants, may be made so often as once a-week. The cuttings should be very close in summer; and after the plants have been cut about three times, they

begin to stock, and may thenceforth be cut freely and often.

WATER DOCK. See Dock.

WATER DROPWORT. See Dropwort (Water).

WATER ELDER. See Guelder Rose.

WATER FARCY. A dropsical disease in the horse,—excited by catarrh, fever, or inflammatory action, and sometimes tending toward true farcy or glanders. Blaine calls it "that protean complaint beyond definition;" and adds, "Gibson is not very wide of the mark when he describes it as of two kinds,—one resulting from febrile attack, the other partaking of the nature of dropsy. A limb in these cases is often suddenly seen to be gorged, and often so much so as to press out the diseased accumulations, which are seen around it like dew-drops. Mr. Percivall considers it as of an inflammatory character, as did also Professor Coleman. One singularity of it, which is noticed by Mr. Percivall, and must have been also observed by others, is, that it often confines its attack to one limb only. It will sometimes break out in a state of grease; and sometimes it will extend itself to the opposite limb also. The treatment of water farcy should be prompt, or true farcy may follow. Mr. Percivall recommends to take two gallons of blood from the horse, and to follow that up by a mercurial and aloetic purge: bleed again in two or three days, and continue a ball daily of a mild kind, composed of aloes, calomel, digitalis and Venice turpentine; and follow this treatment with tonics, as blue vitriol, gentian, &c." See the articles Farcy and Dropsy.

WATER FURROW. See Draining and Ploughing.

WATER GLADIOLE. See Butomus.

WATER GERMANDER. See Germander.

WATER HEMLOCK,—botanically *Phellandrium*. An indigenous biennial plant, of the umbelliferous order. It constitutes a genus of itself, and is specifically called the aquatic. It inhabits ditches, rivulets, and ponds in most parts of Britain; and though somewhat scarce in most districts of the country, is abundant in muddy ditches and pools in the vicinity of both London and Edinburgh. It has a height of about 3 feet, and carries white flowers in June and July; and it sufficiently resembles some of the cultivated umbelliferous plants to be readily mistaken for them by ignorant or superficial observers. It is a narcotic poison, of considerable violence, yet has been used medicinally in cases of pulmonary consumption and some other diseases. It takes its botanical name phellandrium, which signifies "to deceive a man," from its liability to be mistaken for some of the innoxious umbellifers.

WATER-HEN,—scientifically *Gallinula chloropus*. A large British bird belonging to the long-toed family of grallæ. It has a near resemblance to the water-rail, particularly in the bill; but may be readily distinguished from it by its greater size, by the shield on its forehead, and by its very long toes furnished with a very narrow border. It has congeners in almost every part of the globe; and though not in the ordinary or large sense a migratory bird, it makes partial flittings from one district to another, and is found in summer on cold mountainous tracts, and during winter in lower and warmer situations. It abounds in many parts of Britain; and frequents the weedy, willowy, and tangled banks of ponds and streams, perching on the boughs of low bushes, concealing itself during the day among thick and impenetrable recesses, and running and skulking in the evening among the roots of bushes and long loose herbage by the margin of the waters in quest of its food. It lives on worms, water-insects, aquatic plants, and seeds; and it likewise picks up corn from the neighbouring stubbles. It is at all times very good eating; but from September till December, its flesh is extremely delicious. The female forms her nest with a large quantity of withered reeds and rushes closely interwoven, in a retired spot, close by the brink of the waters, and frequently places it upon some low tree or stump by the water side. She lays seven eggs, each nearly two inches long, of a yellowish white colour, marked with irregular reddish brown spots; and is said never to leave the nest during incubation, without covering the eggs with the leaves of the surrounding herbage. She has two and sometimes three hatchings in a summer. The young brood remain but a short time in the nest, under the fostering care of the mother; and as soon as they are able to crawl out, they take to the water and shift for themselves. In the spring, the water-hen has a shrill call; it strikes with its bill like the common hen; its flight is slow and awkward, with the legs hanging down, and to no great distance at a time; and in running, which it does pretty fast, the tail is so flirted up as to show the under white feathers. The total length of the bird is about 14 inches; the breadth 22; the weight from 12 to 15 ounces. The bill is red, with a greenish yellow tip, and upwards of an inch long. At the base of the bill a singular kind of red membranous substance shields the forehead as far as the eyes; and this in the breeding season has the colour of sealing-wax, and at other times varies or fades into a whitish colour. The head is small and black, except a white spot under each eye; the irides are red; the plumage of the upper part of the body has a sooty black colour, tinged with shining olive green; the outer edge of the wing, the outside feathers of the tail, and the under tail coverts, are white; the vent feathers are black, those on the belly and thighs tipped with dirty white; the long loose feathers on the sides hanging over the upper parts of the thighs are black, streaked with white; above the knee, at the commencement of the bare part, is a circle of red; from the knees to the toes the col-

ours are of different shades, from pale yellow to dark green; the toes are very long, the middle one measuring to the end of the nail nearly 3 inches; the under sides of the toes are broad, being furnished over their whole length on each side with membranous edgings, which enable the bird to swim, and readily to run over the surface of slimy mud; the legs are placed far behind. The body is long, and compressed at the sides, contrary to those of the duck kind, which are broad, flat, and depressed; and the feathers are thickly set, and bedded upon down.

WATER HOREHOUND. See HOREHOUND (WATER).

WATERING POOLS. See POND and WATER.

WATER-IN-THE-CHEST. See HYDROTHORAX.

WATER-IN-THE-HEAD,—*Hydrocephalus.* A dropsy of the head of animals, or diseased collection of serous liquid within the head's circumscribed cavities. It sometimes occurs in individuals of each of the three chief species of farm live stock,—horse, ox, and sheep.

Hydrocephalus in the horse is occasionally congenital, occasionally though rarely idiopathic, and oftener though still rarely the result of irritation of the brain or its membranes from some other disease. It sometimes or perhaps generally commences in a similar way to phrenitis or mad staggers, but more slowly and with much less violence of symptom; but its commencement can seldom be detected, and even in its progress, or the degree in which it has become established, cannot easily be determined. Some bold cure for it perhaps may at some future time be invented by mechanical abstraction of the liquid; but as yet no better practice is known than to attempt absorption by means of vesicants, mercurial unguents, nauseants, purgatives, diuretics, and repeated small bleedings.

Hydrocephalus in fœtal oxen is sometimes so great as to render parturition difficult or impossible; and in every such case the fœtus may be unhesitatingly and promptly destroyed in order to save the cow. The disease also developes itself in some weak and sickly calves; and as soon as it is ascertained to exist, they may be destroyed, as they will never come to any good. A dropsy, not in the ventricles of the brain, but between the membranes, and therefore not indicating itself by any change in the size or form of the cranium, sometimes occurs in adult cattle; but it can seldom if ever be distinguished from apoplexy or flow of blood to the head, except in being milder and slower,—and it may be treated in a similar way, by bleeding and purging.

Hydrocephalus, both of the ventricles and of the enveloping membranes, is not uncommon in both fœtal and young lambs; and, in the former case, is a warrant for promptly destroying them, —and even in the latter, does not admit of cure, unless in rare cases by the natural supply of abundant milk from the mother or from a foster-mother, with the administration of aperient and tonic medicine. Its symptoms in young lambs are dulness, want of appetite, distension of the skull, languor and projection of the eye; and stupid appearance and staggering gait; and it is sometimes mistaken for turnsick or goggles, but may readily be distinguished from that disease by the total absence of gyrating and circular motion in the gait. See the article HYDATID. It seems to be hereditary; and is most commonly caused by general debility in the ewe. If many instances of it occur on a farm, the ram formerly employed should not be employed again; and in every one instance, the ewe should be dismissed from among the breeders.

WATER LEAF. See HYDROPHYLLUM.

WATER LILY,—botanically *Nymphœa.* A genus of ornamental, floating, aquatic plants, constituting the type of the natural order Nymphæaceæ. The botanical structure of this order has been a subject of great dispute among the most eminent botanists,—some contending that it is exogenous, and others that it is endogenous. Its true place seems most probably to be among the many-carpelled thalamiflorous exogens, not far from the barberry and the moonseed families, or even from the magnolia family. All are floating plants of great interest and beauty; and many have flowers of most elegant forms and very pleasing or brilliant hues. Three adorn the waters of our own wilds with liliaceous magnificence; and all the rest perform a similar office—some with vastly more splendour—in other countries. About 20 hothouse species, and upwards of a dozen hardy ones occur in British gardens; and are distributed among the genera nymphæa, nuphar, euryale, and nelumbium. See the articles LOTUS, NELUMBIUM, and NUPHAR.

No fewer than eighteen of the species of Nymphæaceæ in Britain belong to the genus nymphæa; and seventeen of these are exotic. Seven, including the indigenous one, have cordate leaves and white flowers, and, with one exception, are hardy; seven have peltate and for the most part toothed leaves and either white or red flowers, and are all tender; and four have peltate and for the most part entire leaves and blue or bluish flowers, and are all tender. The hardy species may be grown in ponds, canals, and similar collections of water; the stove species require to be grown in tubs of water, placed in a warm part of the house, with some rich loamy soil at the bottom; and all are propagated either from seeds or by dividing the roots, or by separating the tubers.

The indigenous species, or common water lily, *Nymphœa alba,* inhabits the clear ponds and slow clear rivers of many parts of Britain; and is one of the most superb of our native flowering plants. Its root is tuberous and horizontal, and sends down many long stout radicles, with fibrous extremities; its leaves are oval heart-shaped and about four inches wide, and have nearly parallel or close lobes at the base, and are entire and

smooth, and float on the surface of the water; and its flowers are four or five inches wide, and have a calyx with white upper surface, often tinged with pale red, and have white petals and yellow stamens and pistil, and bloom in June and July. The whole plant is slightly vascular, and exhales rapidly, and becomes very soon dry; the leaves have innumerable absorbing pores on the under surface, and innumerable exhaling ones on the upper surface; the flowers emit a faint sweet smell, and expand only in sunshine in the middle of the day, and either recline on the water or sink into it when they close toward evening; and the whole plant, after ripening its seeds in autumn, sinks to the bottom to enjoy there its winter repose. Hogs eat this plant; goats dislike it; and cows and horses totally reject it. The root was eaten in a boiled state by the ancient Egyptians, and is sometimes used as a substitute for corn by the modern Swedes,—but requires, for all esculent purposes, to be well divested of its bitter taste by frequent washings; and it is used in Ireland and the Hebrides for dyeing a brown colour, and might be used also for tanning and currying leather; and is said to have been found serviceable for the cure of leprosy. The stems are better than oak-galls for dyeing grey; and the seeds were used by the ancient Egyptians as a bread-stuff. Young plants appear in the following spring from ripe seed-vessels thrown, immediately after their becoming ripe, into still ponds or large ditches; and an old plant may be removed by carefully digging up the root with a large ball of mud from beneath the water, placing it in an old fish basket, and sinking the whole in the place where it is intended to remain,—leaving the plant to make slow and firm anchorage for itself during the decay of the basket.

WATER LILY (Yellow). See Nuphar.

WATER MEADOW. See Irrigation.

WATER MELON. See Cucumber.

WATER MILFOIL, — botanically *Myriophyllum*. A small genus of aquatic plants, of the haloragis family. The whorled species, *M. verticillatum*, inhabits ponds in some parts of England, and carries herbaceous-coloured flowers in July; and the spiked species, *M. spicatum*, inhabits ditches in both England and Scotland, and carries red flowers from June till August; and both have perennial roots, stems about a foot long, floating foliage, and a weedy appearance. Some tropical species are known.

WATER MILL. See Mill.

WATER PARSNIP, — botanically *Sium*. A genus of herbaceous plants, of the umbelliferous order. Four species grow wild in Britain; nearly a dozen have been introduced from other countries; and upwards of another dozen are known. Several are poisonous, and most of the others are more or less acrid and dangerous; yet one which was long ago introduced from China is culinary, and will be found described in the article Skirret. All the species in British collections are perennial-rooted; some are tuberous, some creeping, and some erect and annual-stemmed; two are yellow-flowered and the rest are white-flowered; all are more or less aquatic, and none possess any attractions for the florist.

The broad-leaved water parsnip, *Sium latifolium*, inhabits fens, ditches, and rivulets in many parts of Britain. The root is fleshy and creeping, and has numerous long fibres; the stems are annual, erect, angular, deeply furrowed, hollow, smooth, leafy, very little branched, and from 2 to 6 feet high; the leaves are pinnate and from 6 to 12 inches long; the leaflets are oblong, lanceolate, and equally serrated; the flowers come out in both axillary and terminal umbels, and are small, numerous, and of a snow-white colour, and bloom in July and August; the fruit is small and of an elliptic-ovate form; and the seeds have an aromatic flavour. The whole plant is poisonous; and the roots and herbage of it more so than the seeds. Hogs and horses eat it, but sheep abhor it.

The narrow-leaved water parsnip, *Sium angustifolium*, also inhabits the ditches and rivulets of many parts of Britain. It is only about half the size of the broad-leaved species. The root is extensively creeping; the stem is erect, annual, cylindrical, striated, and much branched; the leaves are simply pinnate; the leaflets are unequally lobed and serrated; the umbels are stalked opposite to the leaves; the flowers are white, and bloom in July and August; and the fruit is roundish-ovate, and has three dorsal ribs and two lateral ones on each side.

The procumbent or knot-flowered water parsnip, *Sium nodiflorum*, also inhabits the rivulets of Britain. It is an evergreen creeper, and has seldom a height of more than 6 or 8 inches. The stems are cylindrical, hollow, striated, branched, of variable length, procumbent or floating, and in many instances creeping; the leaflets are ovate and equally serrated; the umbels are nearly sessile, and grow opposite to the leaves; the flowers are small, and have a greenish white colour, and bloom in July and August; and the fruit resembles that of the narrow-leaved species, but is more acute in the ribs. The juice of this plant has been recommended, very injudiciously and dangerously, for cutaneous affections.

The creeping water parsnip, *Sium repens*, inhabits boggy meadows, watery commons, and other moist grounds in various parts of Britain. It is smaller than even the procumbent species; but resembles it in being a creeping evergreen. The stems are slender, quite prostrate, and decidedly creeping; the leaflets are roundish and deeply toothed; and the flowers are white and bloom in June.

WATER PEPPER. Two hardy, floating, aquatic, annual plants, of respectively the carnation and the polygonum families. The common water pepper, *Elatine hydropiper*, has a curious ap-

pearance, and a height of about two inches, and carries white flowers in August, and was introduced to Britain long ago from the south of Europe. The mild water pepper, *Polygonum mite*, has an ornamental appearance, and a height of about a foot, and carries red flowers from June till August, and was introduced to Britain in 1800 from North America.

WATER PLANTAIN. See ALISMA.

WATER PURSLANE,—botanically *Peplis*. A small genus of curious small plants of the salicaria family. The common species, *Peplis portula*, is an annual indigen of watery places with sandy, gravelly, or moorish soil in many parts of Britain. The root is fibrous; the stems are quadrangular, smooth, leafy, 3 or 4 inches long, prostrate, floating, and in many instances creeping; the leaves are opposite, stalked, obovate, entire, smooth, and scarcely an inch long; and the flowers are axillary, solitary, almost sessile, small, and reddish, and have the petals so concealed by the calyx as to be scarcely visible, and bloom from July till September.

WATER-RAIL, — scientifically *Rallus Aquaticus*. A shy and solitary yet abundant bird constituting the type of the rail family of grallæ. It is distinguished, in common with all its family, by the comparatively great length of its toes; and in most other respects, it somewhat closely resembles the majority of them, particularly the corn-crake, but has a longer bill than any. Its total length is 12 inches, its breadth 16 inches, and its weight 4½ ounces. The bill is slightly curved, 1¾ inch long, and of a dusky black colour, but reddish at the base; the irides are red; the top of the head, the hinder part of the neck, the back, the scapulars, and the coverts of the wings and tail, are black edged with dingy brown; the under parts of the body, from the chin to the middle of the belly, are ash colour, but in some individuals, supposed to be young ones, are margined with white; the side feathers are beautifully crossed with black and white, and slightly tipped with reddish brown; the inner side of the thighs, the belly, and the vent, are pale brown, sometimes speckled with bluish ash-colour; the under tail coverts are white; the quills are dusky; the tail consists of twelve short black feathers, edged and tipped with dusky red, —some of those on the under side barred with black and white; the legs are placed far behind, and have a dusky red colour; and the toes are long, and have not any connecting membrane. The flesh has a delicious flavour. The eggs are more than 1½ inch long, and have a pale yellowish colour, marked all over with dusky brown spots. This bird abounds in the marshes of Sweden, Norway, Russia, and the southern and central parts of England, but is seen in the northern districts of Britain only during winter. It loves most such low, moist banks of ponds and streams as are overgrown with reeds, sedges, and other coarse aquatic herbage; it runs expertly and furtively athwart its haunts, occasionally flirting up its tail, and practising great adroitness in diving out of the view of any possible observer; it greatly resembles the corn-crake both in agility of ground motion, and in aversion to take flight; it generally tantalizes and disappoints the sportsman, and often exhausts his patience and distracts his dog, seldom rising till it has crossed every pool and skulked through every avenue within the sphere of its retreats, and sometimes even taking to the water, swimming the open parts tolerably well, and flitting with great speed over parts which are overgrown with aquatic vegetation; but when once it becomes flushed, it fags in running, takes to the wing, flies very indifferently, with its legs hanging down, and is easily shot.

WATER REED. See ARUNDO.

WATER SICKNESS. See DROPSY.

WATER SOLDIER,—botanically *Stratiotes*. A small genus of aquatic plants, of the hydrocharis family. The aloe-like species, or water-aloe, *Stratiotes aloides*, inhabits deep ditches and pools in some parts of England; and is an object of much beauty and elegance, yet sometimes fills its habitats, and even places where it is artificially planted, with such a phalanx of sword-like-leaves as to become almost a troublesome weed. It is a stoloniferous perennial; and has numerous smooth radical leaves, and a solitary central flower-stack, but no proper stem. It floats on the surface of the water during summer, sinks to the bottom after blooming, and sends out long simple runners on the mud; and each runner terminates in a bud or young plant, which first forms several long radical fibres, and effects an anchorage in the mud, and then in summer rises to the surface of the water, there to go through the processes of flowering; and after having bloomed, it sinks in the water, matures its seeds, sends out runners, and dies. The leaves have an acute form and a highly vascular structure, and are fringed with very sharp saw-like teeth, and measure 4 inches or upwards in length; the flower-stalk is firm, strong, two edged, and much shorter than the leaves; and the flowers are white, large, and beautiful, and bloom in June and July.

WATER STARWORT. See CALLITRICHE.

WATER VIOLET. See FEATHERFOIL.

WATERWORT,—botanically *Elatine*. A small genus of curious floating aquatic plants, of the carnation family. The three-petaled or small waterwort, *Elatine tripetala*, grows wild on the margins of ditches and ponds in sandy tracts, in many parts of Britain. Its roots are annual and comprise many long fibres; its leaves are opposite, and have a roughness of surface occasioned by numerous minute points; and its flowers have a pale flesh or reddish colour, and are for the most part three-cleft, and bloom in August. An introduced exotic species is noticed in the article WATER PEPPER.

WATSONIA. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. Nearly twenty species have been introduced to the greenhouses of Britain. They vary in height from 5 or 6 inches to about 4 feet; they display great diversity in the colour of their flowers, composing white, carmine, lake, pink, crimson, scarlet, purple, and variegations; and some bloom in spring, others in summer, and others in autumn. All love a mixed soil of sand, peat, and loam, and are propagated from offsets.

WATTLE. A kind of hurdle formed of split wood, and used either in the same way as hurdles or for any similar purpose. See the article HURDLE.

WAX. A substance of medium character between a fat and a resin. The best known kind of it is a peculiar and abundant secretion or product of the honey bee. See the article BEE. On straightening the lower part of the body of the insect, and raising the segments into which it is divided, eight little bags will be discovered, four on each side; these are the wax bags, and belong to an organ the secretions of which contribute to form the wax,—and this is elaborated from the same substances which are collected for the honey. It is certain that bees confined and fed upon sugar only, form wax; and it is equally certain, from long and careful experiment, that they could produce no wax if they had neither sugar nor honey to make it from, when debarred from flowers. It is therefore a reasonable inference that the substance sucked in by the bee from the nectaries of flowers forms both wax and honey, the difference consisting only in the mode of its elaboration, and in the peculiar secretions of the stomach, and the organ to which the wax-bags belong. Hüber found that from sugar bees produced much more wax than from honey. The natural colour of wax is the purest white; in which state, and quite odourless, the new cells of the honeycomb remain, until filled with the luscious deposit they are formed to contain. The yellow colour which the wax assumes, is therefore due to the honey, —a portion of which always remains in the wax until bleached; and indeed one of the strong characteristics of bees' wax, with reference to any other wax, is the odour of honey which it retains in its unbleached condition. The wax of bees has the same precise elements as that found in vegeble matter; and, though an animal product, it contains no nitrogen. Dr. Ure makes it to consist of thirteen atoms of carbon, eleven of hydrogen, and one of oxygen; which would thus make eleven atoms of olefiant gas or bicarburetted hydrogen, one atom of oxide of carbon, and one atom of surplus carbon,—because olefiant gas is formed of an atom of carbon and an atom of hydrogen, whilst oxide of carbon consists of one of carbon and one of oxygen—the hydrogen and carbon in the former being bulk to bulk, the carbon in the latter being double the bulk of the oxygen. The odd atom of carbon seems so singular that there was perhaps an error in the analysis, so that there may really exist twelve atoms of hydrogen instead of eleven; in which case the constituents of wax would be twelve atoms of olefiant gas and one of oxide of carbon. It is this richness in olefiant gas which renders wax so valuable a combustible material for affording light; and if it were plentiful enough to be converted into gas, the light from it would be probably much more brilliant than that from even oil gas.

Two separate principles are found in wax, which of themselves constitute two different wax-like substances having distinct properties. If pure wax be treated with boiling alcohol, a considerable portion of it is dissolved. The solution, when cool, deposits the substance called *cerin.* If the portion of the wax undissolved be again treated with boiling alcohol, an additional quantity of cerin is obtained, and so on until no more of the residuum will dissolve. This residuum is *myricin,*—a substance much denser than wax, insoluble in boiling alcohol, and of the same specific gravity as water. The average proportions, in bees' wax, of cerin and myricin are about 75 parts of the former, and 25 of the latter. Cerin is perfectly white, strongly resembling bleached-wax; it is decomposed by distillation, and is fusible at a temperature more than 20° lower than this latter; and if treated with caustic alkaline ley, it is converted into margaric acid, and a substance termed *cerain.* Myricin is greyish white; and it does not decompose in distillation, but may be vaporised with scarcely any change Though cerin, when separated from wax, will form margaric acid, which is a product of saponified fat, wax itself will not saponify with the alkalies, a fact that distinguishes it from fats, oils, and resins. Wax therefore contains neither elain nor stearin, the two principles of fat and oil, resins containing both in a very concrete form.

For making candles, for the use of the surgeon the perfumer, and the confectioner, for modelling, doll-making, and for many other purposes, yellow wax must be rendered white. It is usually bleached by the following process:—Being melted by either hot water or steam in a vessel of wood or copper tinned, the clear liquid is poured off from the sediment into an oblong trough with a line of holes in its bottom, through which the melted wax runs upon wooden revolving cylinders set horizontally, the lower half of their diameter as they revolve being immersed in cold water. By these means the cylinders become covered with thin layers or ribbons of wax, which are stripped from them, and set to blanch in the sun, during which process they are kept constantly wet. The blanching takes place in an open field, the wax being laid upon long webs of canvass, stretched horizontally two or three feet above the surface of the soil, and then

covered with nets to prevent the wind from blowing it away. Being watered continually, it soon becomes white. If the blanching does not go on well, the wax is remelted and again run upon the cylinders. The sunbeams are so indispensable to blanching wax, that it will not keep its colour if blanched under rain, which also makes it lose a portion of its weight. On the Continent, either alum or bitartrate of potash is incorporated with the wax in the first melting. At Le Mans, where the best wax candles are made in France, great attention is paid to the process of blanching. When the ribbons are completely white, the wax is melted, strained through silk sieves, and run into their circular discs. White wax purified, when in thin plates, besides its delicate whiteness, is translucent, but not so much so as spermaceti. Candles made of the latter are called in France bougie diaphane, or *diaphanous candle*, whilst the wax light is termed simply bougie, to distinguish it from chandelle, which signifies a candle made of tallow. In Paris, and many other towns in France, all the wax candles sold are termed bougies du Mans, from the circumstance of Le Mans being celebrated for its wax lights; though the real bougie du Mans brings a higher price than any other, on account of the brilliancy of its light, which never requires the aid of snuffers. Attempts have been made to bleach wax with chlorine, also with the chlorinated alkalies, soda, potash, and lime; but such attempts have been unattended with success, because all those bleaching preparations render the wax brittle, and impair its property of yielding light. The average specific gravity of pure white wax is 0·962, taking water at 1·000. It melts at 155° Fahreinheit; but it becomes soft and plastic for the purposes of the arts at 86°. At the freezing point, 32° Fahrenheit, it is hard, and as brittle as black resin.

Vegetable wax exists ready formed in several trees, in the juice of some plants, in the pollen of many flowers, in the skin of plums and other fruits, and is a constituent of the green fecula of several plants, especially the cabbage. It also forms a varnish upon the upper surface of the leaves of many trees; it may be found in the juice of the cow-tree, and upon the stem of the violet variety of the sugar-cane; and it abounds in the bark of the *Ceroxylon andicola*, and in the berries of the *Myrica cerifera*, the *Myrica carolinensis*, the *Myrica latifolia*, and the *Myrica angustifolia*. There is also a tree common on the Malabar coast, and scarcely known in England, which yields immense quantities of a beautiful light green wax, easily blanched, and producing a splendid light; and, under proper cultivation, this wax might form a lucrative branch of trade, and very much improve our candle manufactories, now greatly dependent upon the north of Europe for their supply of tallow.

Vegetable wax is composed of the same principles as the wax of bees, but is generally of greater specific gravity, from possessing a larger portion of myricin; and this is perhaps the reason why nature makes the insect elaborate and not collect it,—the wax for the honeycomb no doubt requiring an excess of cerin, whilst that for vegetable purposes is more effective with a larger proportion of myricin. All the chief kinds of vegetable wax, however, differ somewhat widely from one another, both in some of their outward properties and in the processes by which they are separated from the plants and converted into use. The wax of the *Ceroxylon andicola*, or cera de palma, abounds most on the central cordillera of New Grenada, and is separated in its crudest state from the tree by scraping the bark. The scrapings are boiled in water; the wax swims in a softened though unmelted state on the top; the impurities fall to the bottom; and the purified wax is formed into balls and set to dry in the sun. It is with this substance, to which however a small quantity of fat is often added to render it less brittle, that the loaves of wax and the candles of the country are formed. After it has been melted, the cera de palma is of a deep yellow colour, slightly translucid, as brittle as resin, and presenting a waxy fracture well characterised. Its melting point is a little above that of boiling water. Boiling alcohol dissolves it readily, and in cooling the solution sets into a gelatinous mass. Ether dissolves it, as do also the alkalies. The wax of the *Myrica cerifera*, is procured by boiling the fruit in water. The tree is extremely common in Louisiana and the temperate regions of the Andes. The fruit yields as much as 25 per cent. of wax; and a single shrub will yield from 24 lbs. to 30 lbs. of berries per annum. The crude wax is green and brittle; and, in order to be made into candles, requires the addition of a certain quantity of grease. The wax of the sugar cane is gathered from a powder or bloom of a waxy nature, which melts at the temperature of 180° Fahr. This wax is so hard that it can be pulverized; and it may be made into candles, which for the brilliancy of their light are not inferior to those of spermaceti. M. Avequin, who directed attention to this subject, found by his experiments that a hectare, nearly 2½ English acres, of the violet cane would furnish nearly 200 lbs. of wax. The wax of the *Myrica carolinensis*, is noticed in the article Wax Tree.

There is also a mineral wax called ozocerite, found at the foot of the Carpathian Mountains, and lately, but in very small quantities, in the north of England, near the coal mines. This substance has less tenacity than wax; it easily crumbles, and can be beaten to powder in a mortar. Its specific gravity is also less than wax, being about 0·926. Its colour is different shades of brown; but it will bear bleaching. In even its natural unpurified state it is translucent. Its melting temperature is the same as bees' wax; its plastic temperature 100° Fahrenheit. In

Moldavia, the ozocerite is used for candles, which, however, do not give so good a light as those made of bees' wax.

A great deal of wax is imported into this country, in addition to that which we obtain from our native hives; for it is used in many of the arts, both common and fine. Besides the manufacture of wax candles, many thousands of individuals gain their living by making wax dolls, to say nothing of the forming of wax-work portraits, and the modelling of objects of still life and fruits,—in both which frequently much talent and considerable ingenuity and knowledge are displayed. To the engraver, wax is an indispensable object, as well as to the artist-painter, the architect, and the sculptor. In numerous useful crafts, as in many of the more scientific manufactures, wax is an article of peculiar utility; and it forms the base of the salves, ointments, and cerates of the surgeon, and occupies a similar place in the sweet-swelling pomatums and unguents and cold creams of the perfumer. It is also a valuable aid to medicine. Its demulcent properties render it very efficacious in diarrhœa and dysentery and in other cases where it is required to assist in protecting the mucous membrane of the stomach from the effect of any acrid or poisonous substance. It is generally administered first melted with olive oil, and then triturated with yolk of egg, adding, by degrees, a solution of gum-arabic, or some other mucilaginous liquid.

WAX MOTH,—scientifically *Galleria Cereana.* A bee-infesting moth, of the tinea family. The male measures about an inch from tip to tip of the expanded wings; and the female is considerably larger. The upper wings of the male are short and obtuse, and have a dusky grey colour, considerably varied in the tint, with a brown-spotted whitish band from the base to the middle; the under wings have an ash or brownish grey colour, with brown fringes and white extremity; the body is yellowish brown; and the legs are yellowish grey with spots of a lighter colour. The upper wings of the female are longer and straighter, and have the white band very faint; the under wings are white, with dark grey border and veins; and the head and the back are dark rusty brown. The female lays her eggs in bee-hives, and usually accomplishes her object in the night, when the bees are at rest. "She commonly places them in some crevice about the lower parts of the hive; but she even ventures at times to enter the hive, and lay them among the combs. Whenever the caterpillar first sees the light, its instinct immediately leads it to the combs, among which it penetrates, forming winding galleries, which are lined with strong silk, so thick that the stings of the bees cannot take effect through it. There is a difference of opinion among apiarians as to what portion of the contents of the hive this intruder chiefly employs for food. Some allege that it confines itself to the wax; others, among whom is Feburier, whose opinion is entitled to consideration, assert that it devours neither the honey nor the wax, but the exuviæ of bee-nymphs, and, very probably, the nymphs themselves. But, however this may be, the devastation caused by these caterpillars, when at all numerous, (and 300 have been found in a hive,) is speedily destructive to the prosperity of the hive; the bees gradually give way to them, and ultimately are often compelled to quit the field altogether. When full-grown, the caterpillar is about an inch long, of a dull white colour, with a brown head, and covered with small brownish tubercles, from the centre of which springs a slender hair. They attain their full size in three or four weeks after being hatched, when they prepare for becoming pupæ, by weaving a very strong web, either in some of the tubes they had formerly excavated, or in some secure corner of the hive. On the Continent there are two broods in the year; but it does not appear whether this be likewise the case in this country. Here the moth is not nearly so plentiful as in many other parts of Europe. A nearly related species, *Galleria alvearia*, likewise occurs in Britain, but it is even scarcer than that just described.—There is but one sure method of clearing the bee-hives of the wax moth; and this consists in looking for and destroying the larvæ and pupæ. If the hives are examined only once a week for this purpose, any traces of covered passages will easily be perceived, and must be immediately removed and destroyed with the caterpillars in them. The corners of the hive must also be closely examined in case of cocoons being there, which must also be destroyed. A lighted candle has been also recommended to be held before the hole of the bee-hive, that the moth, flying out to the light, may be burned. But this is labour in vain, for the female does not leave the hive till she has laid her eggs; and it is only supernumerary males that perish in the flame."

WAX TREE. Any tree or shrub which yields vegetable wax. See the article Wax. But the name is emphatically and even distinctively given in some English works to the *Myrica Carolinensis*,—an ornamental, economical, hardy, evergreen, amentaceous shrub, which was introduced to Britain from North America in 1730. Dr. Hamilton, writing in 1826, and recommending this plant for extensive cultivation in waste tracts of the South of England, says, "It is perfectly acclimated in France, where it flourishes luxuriantly in a sandy and blackish turf, rising from the height of four to six or even seven feet, producing in general an abundant crop of berries every year, and requiring little care in its culture. It is readily propagated, either by sowing the seeds in spring, and afterwards transplanting, or, which is the most expeditious method and equally successful, by taking off the young shoots, which rise in profusion at the base of the larger shrubs,

and planting these out at the distance of about three feet from each other. The *Myrica Carolinensis* succeeds wherever the soil is light and rather moist; and has been long known to flourish even in the dry sands of Prussia. In this latter kingdom, as we learn from an interesting memoir of Charles Louis Cader, inserted in the Annales de Chimie, it was successfully cultivated by the late Mr. Sulzer in a garden on the banks of the Spree, half a league from the city of Berlin, in latitude 52° 53′, which is nearly a degree and a half further north than London, and where the mean annual temperature is only 2° 9′ higher than that of London. Here the wax tree attracted the peculiar notice of every visitor by the delicious odour of its leaves, which they preserved a long time, and the fragrance of its berries. The wax obtained from these berries was also so highly odoriferous, that a single candle formed from it not only perfumed the room in which it was lighted during the period of its burning, but also for a very considerable time after it was extinguished. From what has been said we may, I think, fairly conclude that this valuable plant is capable of being successfully cultivated in the light sandy soils of a considerable part of Hampshire, in the Isle of Wight, in the vicinity of Plymouth, and in many parts of the open, and, at present, neglected tract in the neighbourhood of the Lizard, where acres, now not worth 2s. 6d. an acre for their produce above ground, might be made almost to rival on their surface the wealth which they conceal in their bowels. In America, a very fertile shrub will yield nearly 7 lbs. of berries, 4 lbs. of which yield 1 lb. of wax. This, when melted, is of a greenish yellow colour, and of a firmer consistence than bees' wax. Candles made of it give a white flame and good light without smoke, and do not gutter like tallow candles. When quite fresh they afford a balsamic odour, which the inhabitants of Louisiana esteem highly salubrious. The following is the simple process by which the wax is separated from the berries. Having collected a sufficient quantity, they are thrown into a kettle and covered with water to the depth of about six inches; the whole is then boiled, stirring the grains about, and rubbing the berries against the sides of the vessel to facilitate the separation of the wax, which rises to the surface of the water like fat, and is skimmed off with a spoon, after which it is strained through a coarse cloth to free it from impurities. When no more wax rises, the berries are removed with a skimmer, and a fresh supply put into the same water, taking care to add boiling water to supply the place of that evaporated during the process, and changing the water entirely after the second time. When a considerable quantity of wax has been thus obtained, it is laid upon a cloth to drain off the water still adhering to it; after which it is dried and melted a second time to purify it, and is then formed into cakes for use." See the articles Wax and Candleberry Myrtle.

WAX (Vegetable). See Wax and Wax Tree.

WAY BENNET. See Barley.

WAY-BREAD. See Plaintain.

WAYFARING TREE. See Viburnum.

WEANING. The means employed to induce a young mammalian animal to cease sucking, and to habituate itself to the use of common food. See the articles Foal, Calf, and Sheep.

WEASEL,—scientifically *Mustela Vulgaris*. A digitigrade, carnivorous mammal, constituting the type of a somewhat numerous family, comprising the polecats, the ferrets, the stoat, the skunk, the martens, the otters, and some foreign weasels. It differs remarkably from most other quadrupeds, except those of its own family, in the small proportion which its height bears to its length. Its height is not above 2½ inches; its length from the nose to the tail is about six or seven inches; its tail is only 2½ inches long, and so ends in a point as to add considerably to the apparent length of the body. The back, the sides, and the legs have a prevailingly pale tawny brown colour, resembling that of cinnamon; the throat and the belly are white; each jaw, beneath the corner of the mouth, has a spot of brown; the eyes are small, round, and black; the ears are broad and large, and, in consequence of a fold at the lower part, have the appearance of being double; the cheeks are whiskered like those of a cat; and the teeth amount to thirty-two, and are eminently adapted to the tearing and chewing of the food. The female brings forth in spring, and bestows great care on the comfort of her young, and prepares for them a bed of straw, hay, leaves, and moss. From three to five young ones form a litter, and are born blind, but soon acquire both sight and strength to follow their dam in her excursions. The weasel moves by unequal bounds or leaps; and, in climbing a tree, it gains a height of some feet from the ground by a single spring; and even runs so facilely and nimbly up the sides of a wall as to be able to make good its entrance into a hole or retreat at any altitude and in any sort of situation. It leaps upon its prey at a single bound, and sometimes at one long leap and from a concealed point of observation; and it possesses such flexibility of body and such agility of action as easily to evade the attacks of much stronger animals than itself. It always preys in silence, and never utters a cry of any kind or at any time except a sort of rough squeaking when it is angry or pained. It frequents barns, granaries, outhouses, and farm-yards, and is both a friend and a foe to the farmer, sometimes doing more good than harm, and sometimes more harm than good; and in summer, it ventures to a distance from its usual haunts, and goes in quest of colonies or swarms of rats, and may often be found by the side of water in the vicinity of corn-mills. It serves

the farmer in winter by clearing his premises of rats and mice,—doing far more execution upon them than can be possibly done by the cat; but it sweeps the pigeon-house of both eggs and young birds, and makes fearful havoc in the poultry-yard and upon the hen-roost. It sleeps in its hole during the greater part of the day, and comes forth in the evening to commence its depredations, and may then be seen stealing cautiously from its retreat, and creeping furtively in search of eggs, chickens, pigeons, game, and rabbits. It does not devour on the spot what it kills, but drags it off to be eaten at its leisure; and if it find old hens or cocks abroad from the poultry-yard, it does not scruple to attack them. It has an insatiable and coarse appetite, and loves its food best when reduced to a state of incipient putrefaction, and always emits a very strong and offensive odour. It cannot without extreme difficulty be domesticated; yet it might perhaps be so far tamed as to be rendered serviceable for clearing out rats from ships, close old buildings, and similar places. When it becomes wastefully or insuperably mischievous upon a farm, it may be caught by the hutch or box trap, baited with an egg or a small bird, or destroyed by a mixture of sal ammoniac, white of egg, wheat flour, and honey, laid in small doses near the places which it frequents.

WEASEL-SNOUT. The yellow dead nettle. See the article DEAD NETTLE.

WEATHER. The agencies, phenomena, and departments of weather are fully discussed in the articles METEOROLOGY, ATMOSPHERE, CLOUDS, CALENDAR, WIND, ELECTRICITY, DEW, RAIN, SNOW, FROST, HOAR-FROST, ACCIDENTS, BLIGHT, BAROMETER, ANEMOMETER, and many others whose titles either occur in the chief of these articles, or will readily suggest themselves to all persons desirous of information. Only the subject of weather-prognostics remains to be discussed here; and even this has elsewhere been so fully disposed of as to its principles, that it requires to be discussed here with reference only to facts and appearances.

"The study of the changing phenomena of the atmosphere," remarks our contemporary, W. Cuthbert Johnson, Esq., "has from the earliest periods occupied a greater or less share of attention from the tiller of the soil, the gardener, and those engaged in the pasturage of animals. To no individual (the mariner, perhaps, excepted) is a foreknowledge of the probable future state of the weather of more consequence and importance than the agriculturist; for on this must mainly depend the progress and success of his field operations, his seed-time and his harvest, and the greater or less return afforded by his crops. It may not comport with the dignity of the man of science, or the elevated learning of the erudite philosopher, to have his eyes and ears open to the plain and simple rules and guides which nature lays out before him. Perhaps he has little of leisure to note the everyday phenomena which the atmosphere and all animate and inanimate nature hold up to observation, as in a glass, where all who use their eyes may read as they run. The companions of his study are the more costly and elaborately prepared philosophical instruments; how much, however, might their value be enhanced by a careful and comparative observation of the 'skyey influences,' as the poet terms them? But to these closet companions the husbandman, the shepherd, the traveller, the fisherman, and the mariner have rarely access, while engaged in the busy out-of-door occupations of their several avocations. Those who till the land, or who go down to the sea in ships, of all others, are they who become, by habits of observation and reflection, most conversant with the signs and changes of the heavens. The sun, the moon, and the stars are to them monitors and instructors, whose warning voices meet a prompt and ready response. The ripple of the wave, the curl of the smoke, the passing shadow of the cloud, the budding of the tree, the arrival and departure of the migratory birds, the frolicsome gambols of animals, every leaf that quivers in the sunbeam, every plant that drinks the dew of heaven, the myriads of insects, and creeping things innumerable, that inhabit each leaf and opening flower, are all fraught with instruction and information to the experienced and watchful observer. Around, above, beneath, all animate and inanimate creation, animals, vegetables, the elements, a thousand objects in a thousand directions, in every recurring season, furnish their quota of information towards our stock of meteoric knowledge, and foretell the approaching variations of atmospheric phenomena. The experienced fisherman and the watchful and wary mariner will predict the coming storm, by the tiny cloud and other unerring criteria which frequent and attentive observance of the sky has rendered familiar, long before its approach is visible to the ken of the ordinary and inattentive observer. It has been well remarked, that 'the shepherd, whose sole business it is to observe what has a reference to the flock under his care, who spends all his days and many of his nights in the open air, under the wide-spread canopy of heaven, is obliged to take particular notice of the alterations of the weather; and when he cares to take a pleasure in making such observations, it is amazing how much progress he makes in them, and to how great a certainty he arrives at last, by mere dint of comparing signs and events, and connecting one observation with another. Every thing in time becomes to him a weather-gauge; the sun, the moon, the stars, the clouds, the winds, the mists, the trees, the flowers, the herbs, and almost every insect, animal, and reptile with which he is acquainted—all these become, to such a person, instruments of real knowledge.' To the farmer, a careful

study of the weather, and of the inferences to be drawn from precedent and from natural and artificial data, comes fraught with numerous and important considerations. Like the angler, the husbandman 'must observe the wind, sun, and clouds by day; the moon, stars, and waves of the air by night.' Few are so entirely dependent on the caprice of the weather, for the commonest routine operations of the farm, as the agriculturist."

Many of the most common weather-prognostics have been observed in all ages from very ancient times till the present day, and in all sorts of countries of similar climates and latitudes from the most barbarous to the most civilized, and by all classes of the population interested in them from the most boorish peasant to the most intelligent land-owner. A very eminent writer on them was Aratus, a Greek poet, who lived so long ago as about 270 years before the Christian era. In fact, "it is their being familiar to almost every age and country," as Mr. Foster remarks, "which affords the strongest confirmation of their correctness to those who have not had constant experience of them." Some popular prognostics, indeed, are founded on mistake, or on very limited and peculiar observation, and therefore possess no value, or oftener mislead than direct; and even all, or almost all, are denounced by certain theoretic writers as matters of mere superstition, empiricism, and quackery; but the great majority of the best known or most generally diffused are more or less true, and have been founded on extensive and scrutinous observation, and can easily be vindicated or explained by an appeal to heat, light, electricity, atmospheric pressure, and the other physical agencies which control the chemistry of the air and of organic bodies; and even some of the more obscure or seemingly outré ones, which cannot readily or at all be accounted for in the present state of science, rest on such sure observation as to be well worth the attention, not only of farmers for assisting their prescience of the weather, but of meteorologists for prompting and guiding their inquiries into the unexplored or unknown departments of the vast natural agency of our world.

We shall omit all reference here to prognostics by the barometer and by other artificial means, and shall present our readers with a somewhat large collection of natural prognostics, comprising most of the best and many of the middle-rate, but excluding all the inferior or most doubtful; and we shall arrange these in a sort of classified order under the heads of prognostics by plants, prognostics by animals, prognostics by air and sky, prognostics by the heavenly bodies, prognostics peculiar to certain seasons, and prognostics peculiar to upland districts. But we must say to our readers, as Henry Stephens, Esq., the author of the Book of the Farm, says to his, "You must not suppose that all the prognostics of the weather enumerated here will invariably hold true, and that you will be as certain of recognising every phenomenon here described, as if you had contemplated it before you in a picture; or that a great number of them can be observed at one time. Such certainty cannot as yet be attained in predicting and describing the changes of the atmosphere, which are generally presented to us again with such modifying circumstances, as, though the character of the kind may be distinctly preserved, the species or variety of the phenomenon may differ considerably. Still by acquiring at first the leading features of these phenomena, you will afterwards be able, by attentive observation, to recognise most of the particulars which go to make up their distinctive characters. A long-continued state of any kind of weather strongly influences the character of that which is to follow. Thus the barometer sometimes sinks, and even all the clouds present every appearance of rain, and yet no rain follows, and the symptoms subside, and clear weather returns, provided the weather had been long dry before. And, on the other hand, symptoms of drought will fail after a long continuance of wet. Nevertheless, these are only exceptions to the general rule. Be assured that every authenticated symptom is correct, and may be regarded as the forerunner of its effects; and you should be prepared to provide against these, if the symptoms are injurious, although it may happen that the forebodings have not been realized."

Prognostics by Plants.—Plants comprise such an infinity of ducts and cells and air-vessels, holding constant communication with the humidity and gases and heat of the atmosphere, that they may be regarded as delicate and complex hygrometers and thermometers, which, if attentively observed or accurately known, cannot but indicate comparatively minute changes in the state of the air, and therefore foretell vicissitudes in the weather. All wood, even the hardest and most solid, but particularly such as is light and dry, so readily absorbs vapour as to swell in moist weather; insomuch that pieces of sallow dried in an oven, and inserted into drilled holes in the rock of quarries, have been used in damp weather for the same purposes as blasting, —the pieces of wood absorbing humidity from the atmosphere, swelling out like wedges, and rending the rock into fragments. The flowers of many plants open and shut, less under the stimulus of light, than under the action of humidity, and therefore foretell changes from dryness to rain and from rain to dryness; and those of some composite plants, especially, display a sufficient variety of phenomena under the complicated influence of the various atmospheric agencies as to indicate coming changes quite as nicely and curiously as the barometer,—and in consequence are popularly called the poor man's weather-glasses.

The stem of many herbaceous plants, but par-

ticularly that of the common convolvulus and some of the clovers and trefoils, becomes more than usually swollen and upright on the approach of rain. The purple sandwort, *Arenaria rubra*, expands its beautiful pink flowers only during sunshine, and closes them either before rain or at the approach of evening. The dark and beautiful gentianella opens its blue eyes to the mid-day sun, but shuts them on the approach of a shower. The common nipplewort, *Lapsana communis*, the white water-lily, *Nymphœa alba*, and several diadelphous plants expand their leaves during the day in calm mild weather, and contract them during the night. The germander speedwell, *Veronica chamœdrys*, closes its handsome blue flowers at the approach of rain, and reopens them when it ceases. The common wood-sorrel, *Oxalis acetosella*, folds up its beautiful trifoliate leaves, and hangs its flowers toward the ground, on the approach of night or of a storm, and re-expands and redisplays them under the rays of the morning sun. The red campion, *Lychnis diurna*, opens its flowers in the morning; and the white campion, *Lychnis vespertina*, opens its flowers in the evening. The corn-field pimpernel, *Anagallis arvensis*, widely expands its brilliant, small, red flowers on the morning of a fine day, and closes them on the approach of rain. The meadow goat's beard, *Tragopogon pratensis*, will not open its flowers in cloudy weather, and has so regular a habit of closing them at noon that many of the common people call it 'go-to-bed-at-noon,' and the farm-boys of some districts regulate their dinner-time by the closing of its flowers. The winter-green, *Trientalis europœa*, and the alpine whitlow grass, *Draba alpina*, hang down their flowers during the night, particularly in moist states of the atmosphere. The common chickweed, *Stellaria media*, always closes its small, white, upright flowers on the approach of rain, and expands them freely from nine in the morning till noon during dry weather, and holds them pendent during a day or two after rain ceases, or till dry weather has decidedly set in. The Siberian sow-thistle, *Sonchus alpinus*, shuts its flowers in a night preceding a fine day, and keeps them open in a night preceding a rainy or cloudy day. The African marigold, *Tagetes erecta*, keeps its flowers closed after seven o'clock on the approach of rain. Most of the hawkweeds or hieraciums open their flowers early in the morning, and close them in the afternoon. The succory, *Cichorium intybus*, opens its flowers towards the commencement of day-light. The common daisy, *Bellis perennis*, opens its flowers at sunrise, and closes them at sunset. The great white ox-eye, *Chrysanthemum leucanthemum*, closes its flowers on the approach of a storm. The common convolvulus and the broad-leaved red clover contract their leaves on the approach of thunder or of heavy rain.

Prognostics by Animals.—Many animals are strongly affected by electric changes in the atmosphere, and afford, by their sensations or movements, decided indications of the approach, not only of thunderstorms, but of all the more violent forms of weather which powerful electric action causes or controls. Many human beings experience uneasiness, languor, or sense of oppression, and a peculiar kind of headach on the approach of a thunderstorm, even before or long before any symptom of it is discernible in the sky; and many also experience toothach, rheumatism, and peculiar pains in corns, in weak limbs, and in old bruises and fractures, on the approach of heavy rains or high winds, particularly such as are largely controlled by the electric fluid. All animals who are covered with hair or feathers, in consequence of these organised substances being susceptible of very high electrical excitement, must experience strong sensations from great electrical changes,—especially when their bodies happen to be in an opposite electrical condition to that of the inanimate objects around them; and they at the same time possess all or most of the susceptibilities to electrical influence which are possessed by man; and as they are creatures of impulse, and very readily fling their sensations and emotions into action, they may be expected to indicate by many external signs, according to their several organizations and habits, the influence of every considerable atmospheric electrical change upon them, and consequently the approach of a corresponding change of weather. Many of the larger animals, too, must feel uneasiness, and express it, under transitions from dryness to humidity in the atmosphere, or from humidity to dryness; and multitudes of the smaller ones, comprising birds, fresh-water fishes, insects, arachnidæ, molluscs, and annelidæ, are not only affected but guided or impelled in the principal habits of their nature, such as those of feeding, reposing, locomotion, and migration, by the very same vicissitudes in air, heat, electricity, humidity, and aggregate meteorological agency which cause the phenomena of weather,—so that every considerable change or move in their behaviour indicates a contemporary change in the condition of the atmosphere. The recorded prognostics of weather by animals are both numerous and valuable; and multitudes more might no doubt be added by careful, extensive, and minute observation.

When rain is approaching, horses and cattle snuff the air and congregate in corners of fields with their heads to leeward, or seek shelter in sheds,—oxen lick their forefeet,—sheep reluctantly leave their pastures,—goats seek sheltered spots,—asses frequently bray and shake their ears,—dogs are apt to become very sleepy and dull, and to lie all day before the fire, showing a reluctance to all kinds of food except grass,—cats turn their backs to the fire, and wash their faces,—pigs cover themselves more than usually in litter,—rats and mice are more than usual-

ly restless, and forsake the fields and ditches, —cocks crow at unusual hours, and often flap their wings,—hens chuckle,—ducks and geese are unusually clamorous, and fly backwards and forwards, and frequently plunge into water,—pigeons wash themselves, and return slowly to their houses,—peacocks squall loudly from trees, —the guinea fowl makes a constant grating clamour,—sparrows chirp loudly and clamorously, and assemble in crowds on the ground or in the hedge,—swallows fly low, and skim their wings in water,—the carrion crow croaks solitarily, and is late in roosting, — water wild-fowl oftener than usual dip and wash,—moles are busier than usual in throwing up their hills,—frogs croak more than usual, and toads issue from their retreats in great numbers,—bats begin to squeak and enter houses,—the singing birds take shelter,—the robin approaches very near the dwellings of man,—tame swans fly against the wind, —bees cautiously leave their hives, and fly but short distances,—ants are busily engaged in carrying their eggs,—flies severely sting, and become troublesome,—numerous earthworms crawl about on the surface of the ground,—the larger sort of snails appear,—and all sorts of insects are more than usually stirring.

When fair or fine weather is approaching, or may be expected to continue, cattle lie in the open field or in the courts instead of the sheds, —sheep lie on the brow of a knoll during the night,—pigs lie down for the night on the top of their litter,—peacocks roost on the tops of houses,—the raven sails round and round high up in the air,—singing birds carol till late in the evening,—the corn-crake utters his peculiar cry among corn or grass,—the partridge calls in the evening to his mate,—kites hover high in the air,—larks rise high, and sing long,—redbreasts sing loud in the open air,—small flies flock together in great numbers about the beams of the sun a little before it sets,—snipes boom in the air during the evening,—gnats form a vortex in the shape of a column,—spiders' webs are on the ground, or float in the air,—bats fly more numerously than usual, and early in the evening,—and glow-worms appear in unusual numbers.

When high winds are approaching, cattle frisk and jump and toss their heads,—sheep frisk and leap and box one another in sport,—hogs squeal, and carry straw in their mouth,—cats scratch trees or posts,—geese expand or flap their wings, and seem as if trying to fly,—pigeons, in flying, smartly clap their wings behind their back,—crows make somersets in the air, and at the same time are unusually noisy,—magpies assemble in small flocks, and utter a chattering noise,—and swallows fly on the leeward side of trees. And when a storm or tempest is approaching, porpoises come in great numbers near the shore,—sea-gulls come in flocks on the land, and make a noise upon the sea-board,—and the merle-thrush, popularly called the storm-cock, sings loud and long.

Several single species of animals, such as sheep, spiders, ants, and leeches, indicate very delicately and in very various ways great and different approaching changes of weather. In the mountainous district of Derbyshire around the Peak, when sheep wind up the hills in the morning to their pasture and feed near the tops, the weather, though at the time cloudy and drizzling, will clear away by degrees and pass into a fine day; but when they feed in the bottoms, the cloudiness and drizzling will increase into rain, and the wetness of the weather will continue. And in other districts, whether lowland or upland, many actions and habits of all sheep, but specially those of the most distinctive breeds, may be so studied by an intelligent shepherd as to serve nearly all the purposes of a true and nice barometer.—The webs of garden spiders are broken off and destroyed on the approach of rain or of showery weather; and the light spider webs called gossamer fly in autumn with a south wind on the approach of east winds or of fine weather. "If the weather is likely to become rainy or windy," we are told, "spiders fix the terminating filaments on which the whole web is suspended unusually short. If the terminating filaments, on the contrary, are very long, the weather will be serene, and continue so for fourteen days. If spiders be totally indolent, rain generally ensues; though their activity during rain is a certain proof of its short duration, and that it will be followed by fine and settled weather. Spiders usually make some alteration in their webs every twenty-four hours. If this take place between the hours of 6 and 7 P. M., it foretells a clear and serene night."—As to ants, a celebrated naturalist relates that he one day observed these little creatures, after having brought out their corn at eleven in the forenoon, removing the same, contrary to their usual custom, before one in the afternoon. The sun being very hot, and the sky remarkably clear, he could perceive no reason for it; but half an hour after, his surprise ceased,—the sky began to be overcast, and there fell a shower of rain, which caused all this bustle, no doubt, among these active little creatures. They evidently foresaw rain, and provided accordingly. And were we minutely to examine into the economy and management of these wonderful artificers, many other similar and equally curious facts might be gleaned relative to the weather.—As to the leech, "in fair and frosty weather, it remains motionless and rolled up in a spiral form at the bottom of the vessel. Previous, however, to rain or snow, it will creep to the top, where, should the rain be heavy, or of long continuance, it will remain for a considerable time,—if transient, it will descend. Should the rain or snow be accompanied with wind, it will dart about with great velocity, and seldom cease its evolutions until it blows hard. If a

storm of thunder or lightning be approaching, it will be exceedingly agitated, and express its feelings in violent convulsive starts at the top of the glass. It is remarkable, that however fine and serene the weather may be, and to our senses no indication of a coming change, either from the sky, the barometer, or any other cause, yet, if the leech shifts its position, or moves about sluggishly, the coincident results will undoubtedly occur within twenty-six hours."

Prognostics by Air and Sky.—A whirlwind indicates settled fair weather. A wind blowing from the north-east during three days without rain, indicates a continuance of fair weather during eight or nine days. A wind veering hastily about to several points of the compass, indicates the rapid approach of rain; yet such a wind is regarded by some observers as indicating foul weather only when it veers in a course contrary to the sun, that is from west to east, and as indicating fine weather, when it veers in a course from east to west. Any wind which makes a whistling or howling noise is as sure a prognostic of rain as wind can afford. A south wind generally brings rain; but a brisk south wind is usually dry. The rising of a wind is prognosticated by the divergence of the clouds as they come forward on the horizon; and it may be expected either from the point where the divergence takes place, or from the point opposite to that. A southerly wind during a week of fair weather, indicates a continuance of drought; an easterly wind during the former part of summer, indicates a dry summer; and a westerly wind during the latter part of summer, indicates a dry autumn. Winds from the points between the north-west and the north-east, are generally accompanied by fair weather; and winds from points between the south-east and the south-west are generally accompanied by rain. But the characters of winds, in their relations to drought and heat or to raininess and coldness, are much controlled by localities of climate, and differ very widely in different districts of the kingdom, particularly in the eastern coasts and the western, and in the highland districts and the lowland. But, in a general view, north winds are dry, east winds are cold, south winds are wet, west winds are warm, and winds between any two of the cardinal points partake most of the character of that point to which they are nearest. Hence the old doggerel rhymes:—

> "When the wind's in the west,
> The weather's at the best;
> When the wind's in the east,
> It's neither gude for man nor beast;
> When the wind's in the south,
> Of rain there will be fouth;
> When the wind's still,
> No weather's ill."

When clouds fly in two different currents, especially if the lower fly faster than the upper, and more especially if they appear in hot weather in summer, they portend the gathering of a thunder-storm. When small scattered clouds appear in clear weather, or when thin, whitish clouds fly swiftly in a lower stratum than thicker and darker ones above them, they indicate the approach of rain. When a general cloudiness obscures all the upper part of the sky, and when small black clouds drift in the under part in fragments and patches like smoke, rain is not far off, and will probably be of long continuance. When black clouds suddenly arise in the west, or when they appear in that quarter about sunset, they indicate the approach of rain. Clouds which form like fleeces, dense towards the centre, and very white at the extremities, with a bright blue sky about them, are of a frosty coldness, and will soon fall in either snow, hail, or hasty showers of rain. When every one of a series of clouds rises larger than the preceding, and all appear to be in an increasing state, they portend heavy rain, and in some cases a thunder-storm. When vapours have been copiously elevated, and large clouds suspended high in the sky and assume the peculiar appearances indicative of great electricity, and when small pieces of flying clouds augment and congregate, they are certain forerunners of rain, perhaps of very heavy rain and thunder-bursts, if they collect and spread till they cover the sky, but are equally sure symptoms of fair weather if they decrease and resolve themselves into air. Clouds with white summits and livid bases foretell thunder; and two such clouds rising in opposite quarters, or over against each other, foretell a sudden tempest. Clouds streaming within the canopy, small clouds enlarging themselves, large clouds shaped like rocks or towers, waterish clouds on the tops of mountains, and small rugged, livid clouds near the sun, especially at its setting, all prognosticate rain. Clouds which form at a great height, in thin white trains like locks of wool, indicate the approach of wind, and sometimes the approach of both wind and rain. Small, white, high, light clouds, like dapplings in the upper regions of the sky, at a time when all the lower sky and the tops of the loftiest mountains are clear, indicate a continuance of fine weather. When cirrous clouds appear in a clear settled sky, they indicate a change in the weather; when they unite in a somewhat stratous manner, at a comparatively low elevation, they indicate rain; when they appear in a deep blue sky, through a broken cloud, after rain, they indicate that the rain will continue; and when they extend on both sides of the zenith, they foretell a long continuance of high wind. When cumulous clouds are compact, round, and well-defined, they indicate settledness of weather; when they are broken and ragged on the edges, they indicate the approach of rain; when they are curled and thrown outward at the edges, they foretell wind; when they are curled inward at the edges, they foretell a storm; when they remain and aug-

ment during the evening, they indicate the approach of rain; and when they form in the morning and disappear at night, they indicate steadiness of weather. When a great bank or stratum of low cloud dissipates under the influence of the morning sun, it foretells a fine day; when it moves slowly up the mountains, and lingers on their acclivities and round their tops, it foretells rain in the after part of the day; and when it moves slowly down the mountains toward the valleys at their skirts, it affords a certain indication of rain.

When dew is heavy, it indicates fair weather; when it vanishes early or suddenly, it foretells rain; when it abounds on the grass after a fine day, it foretells that the next day also will be fine; and when it is very scanty or totally awanting after a fine day, it indicates that rain is approaching. Either a strong dew or a fog is common between a red evening and a grey morning; and a total or almost total absence of dew is common between a red evening and a red morning. A fog in the morning, in a descending direction, foretells a hot day; a fog in the morning in an ascending direction over a low or level or champaign country, foretells rain; a fog in the morning, in an ascending direction from low lands toward hills and up to hill tops in their vicinity, does not indicate rain; a fog in the morning, resting upon hills and dragging along woods, and not overspreading the low grounds, foretells rain; a fog in the morning descending from hills, and settling in the adjacent valleys, foretells fair weather.

> "When mist takes to the hill,
> Then gude weather it doth spill,
> When the mist takes to the sea,
> Then gude weather it will be."

When a fog is general before sunrise, near the full moon, it prognosticates fine weather. When a white fog, in the evening or at night, is spread over a meadow through which a river passes, it will be dissipated by the morning sun, and the day will be fine and bright. Vapours in the form of exhalations in hot weather, or possessing a medium character between fog and invisible air, when precipitated during the night, are followed by a clear morning sky, but when not precipitated, are forerunners of rain.

When the air feels light and pleasant to a person walking, fine weather will continue; when it feels oppressive to walk in, rain is not far distant; and when it is so very clear as to make distant objects appear unusually distinct and near, it indicates rain. A sky of great height, and pretty clear, foretells fair weather; a sky of small elevation foretells rain; a sky of a deep blue ground colour, foretells fair weather; a sky of a pale blue colour, foretells rain; a morning sky of an orange colour, foretells rain; a sky of crystalline transparency after rain, foretells more rain; a sky which has for some time been thick and dark, without either rain or sunshine, will change to a fair clear sky before rain come. When a lowering redness spreads far upward from the horizon, either in the evening or in the morning, it is succeeded by wind or rain or both; when a fiery redness, with ragged clouds, extends in the evening toward the zenith, it is followed by a high wind from the west or the southwest, accompanied with rain; when a sea-green colour tinges the sky near the horizon, instead of the blue which usually prevails there, it indicates a continuance and increase of rain; and when a dead blue or dark indigo colour prevails over this part, it shows the presence of loads of vapour, and foretells that the weather will be showery. An apothegm exists in most European languages, that "the evening red and the morning grey, are sure signs of a fair day." When, in the morning, some parts of the sky appear green between the clouds, while the canopy above is blue, stormy weather is quickly approaching.

A rainbow in the morning indicates rain; a rainbow in the evening foretells fine weather; a rainbow of a predominantly green or blue colour foretells rain; a rainbow of a predominantly red colour foretells wind; and a rainbow in the north in boisterous weather indicates the approach of fine weather. Lightning without thunder, after a clear day, indicates that the fair weather will continue; but much lightning through the night, either with or without clouds, especially if it be of a pale colour, foretells unsettled weather. Falling stars and fiery meteors generally indicate the approach of high winds, and always indicate a change to some kind of stormy weather; and when the falling stars are numerous, they foretell a storm at day-break. The aurora borealis appears most frequently at a change of weather, either from good to bad or from bad to good. When smoke rises vertically from chimneys in calm weather, it indicates that the fine weather will probably continue; but when it descends and rolls along the ground, it foretells rain. When distant sounds, such as those of bells, waterfalls, and the roaring of beasts, are distinctly heard through the air in a calm day,—or when nearer sounds, such as those of the purling of brooks and the talking of people, seem unusually loud,—they show that the air is loaded with vapour, and indicate that rain may be expected. When the noise of the sea passes southward of the mouth of a river or estuary, it indicates that rain is not far off; and when it passes to the north, it foretells fair weather. Extraordinary or disagreeable scents arising from fenny or meadowy grounds, indicate the approach of rain; and the long continuance of the smell of burnt tobacco, or of the smoke from a tobacco-pipe, or of any similar flavour, also indicates rain. The unusual sinking of rivers presages rain; and a white frost is generally followed by rain within three days. The speedy drying of the surface of the earth, indicates a northerly wind and fair

weather; and a low state of evaporation, indicates a southerly wind and rainy weather.

Prognostics by the Heavenly Bodies.—The sun rising of an orange colour portends rain; his rising of a red and fiery colour, portends rain and wind; his rising unclouded, and emitting a scorching heat from his rays, portends speedy cloudiness and perhaps rain; his rising with a few grey clouds, which decrease and dissipate, portends a fine day and fair weather; and his rising with a dim and hazy disc, portends drizzly weather. When the sun's light is dim, or when it gradually loses its brightness till his disc becomes whitish and ill defined, rain may certainly be expected; and when his light, after rain, though it be sufficiently clear and luminous, is of a watery transparent hue, rain will soon again fall. When sunshine has a scorching and enervating effect on man, during the greater part of the day, the next day will be cloudy and perhaps rainy. When the sun wades through clouds of any kind, rain may or may not follow; when he wades through clouds which of themselves indicate rain, rain will more certainly follow than if the clouds were the only indication of its approach; and when, at the time of his wading, he is surrounded with a coloured corona, rain will most certainly follow. A halo round the disc of the sun almost always portends rain. The sun setting of a dull blackish colour, or of a blue colour, or with the accompaniments which are popularly called foul, portends rain; his setting of a white colour, or going down into a dusky bank of clouds, portends the approach and continuance of bad weather; his setting of a dusky colour, streaked with red, portends a storm; and his setting of a purple colour, or with a bright disc, or with a red and brilliant appearance, or his going down red and blazing amongst brilliant clouds, portends fine weather.

A dimness in the light of the stars, and the visibility of very few stars at one time when there is no frost, are indications of rain. A dimness in the light of the moon, a halo or circle round her disc, and haziness in the air during moonlight, are indications of rain; a redness in the colour of the moon, portends wind; and a clear silvery aspect of the moon, with a silveriness in her light, foretells fair weather. When the new moon appears so early as to be like "the paring of a nail," rain will follow; when the new moon is faintly subtended by the whole disc of the old, or appears "with the old one in her arms," stormy weather may be expected; when the new moon does not appear till the fourth day, the whole month will be more or less rainy; when the new moon is bright, and has sharp horns, she foretells fair weather; when the new moon has blunt horns, she foretells rain; when her lower horn is sullied, foul weather will occur before the full; when her middle is sullied, storms will occur about the full; and when her upper horn is sullied, foul weather will occur about the wane.

"In the wane of the moon,
A cloudy morning bodes a fair afternoon."

"New moon's mist
Never dies of thirst."

"But four nights old (for that's the surest sign),
With sharpened horns, if glorious then she shine,
Next day, not only that, but all the moon,
'Till her revolving race be wholly run,
Are void of tempests."

When rain falls during the greater part of the course of a moon, the weather will clear up at the ensuing change, and rain will probably fall in a few days after, and continue; and when fair weather prevails throughout the course of a moon, and is followed by rain at the change, fine weather will probably be restored about the fourth or fifth day of the new moon, and be of some duration. The following table shows the probabilities of a change of weather at or after each of the moon's situations throughout an entire revolution in her orbit.

The moon's situation.	Nature of the moon's situation.	Chances that the weather will change.
New moon,	When she exerts her influence in conjunction with the sun,	6 to 1
First quarter,	When she is 90° distant from the sun,	5 to 2
Full moon,	When she exerts her influence in opposition to the sun,	5 to 2
Third quarter,	When she is in the middle point of her orbit, being equi-distant from the points of conjunction and opposition,	5 to 4
Perigee,	When she is at the least distance from the earth,	7 to 1
Apogee,	When she is at the greatest distance from the earth,	4 to 1
The ascending equinox,	When she is crossing the equator towards the north,	13 to 4
The descending equinox,	When she is crossing the equator towards the south,	11 to 4
The northern or boreal lunistice,	When she approaches nearest to our zenith during the period that intervenes between one new moon and another,	11 to 4
The southern or austral lunistice,	When she is at the greatest distance from our zenith,	3 to 1

The following table professes to show the kind of weather which will follow every new moon and every quarter of the moon, according to the hour at which the change takes place; but though it is a fair approximation to correctness, and possesses considerable value, and is inserted in almost every almanac, and has been commonly though erroneously ascribed to the greatest astronomer of the last generation, Sir William Herschell, yet it is often falsified in its predictions by the many disturbing and antagonist influences which control the influence of the moon's attraction. When the moon changes, or becomes full, or enters her first or third quarter

between the hours mentioned in the first column, the resulting weather will be as mentioned in the second column in summer, and as mentioned in the third column in winter.

Hours of change.	Resulting weather in summer.	Resulting weather in winter.
Between 12 and 2 afternoon,	Very rainy,	Snow and rain.
Between 2 and 4 afternoon,	Changeable,	Fair and mild.
Between 4 and 6 evening,	Fair,	Fair.
Between 6 and 8 evening,	Fair, if the wind be at north-west; rainy if the wind be at south or south-west,	Fair and frosty, if the wind be at north or north-east; rain or snow, if the wind be at south or south-west.
Between 8 and 10 evening,	Fair, if the wind be at north-west; rainy, if the wind be at south or south-west,	Fair and frosty, if the wind be at north or north-east; rain or snow, if the wind be at south or south-west.
Between 10 and 12 night,	Fair,	Fair and frosty.
Between 12 and 2 morning,	Fair,	Hard frost, unless the wind be at south or south-west.
Between 2 and 4 morning,	Cold, with frequent showers,	Snow and stormy.
Between 4 and 6 morning,	Rain,	Snow and stormy.
Between 6 and 8 morning,	Wind and rain,	Stormy weather.
Between 8 and 10 morning,	Changeable,	Cold rain, if the wind be at west; snow, if the wind be at east.
Between 10 and 12 noon,	Frequent showers,	Cold with high wind.

Prognostics belonging to particular Seasons.—A serene autumn, denotes a windy winter; a windy winter, denotes a rainy spring; a rainy spring, denotes a fine summer; and a fine summer, denotes a windy autumn. But it very rarely happens that the seasons succeed one another in the same tenor for two successive years. If at the beginning of the winter, the south wind blow, and then the north, cold may be expected; but if the north wind blow first and then the south, the winter will be mild. A hot and dry September, portends a cold spring; and a moist and cool summer, portends a hard winter. Dryness at the commencement of winter on walls which are usually damp, shows the air to be dry, or indicates the condition favourable to frost, and therefore portends a hard winter. The early arrival of wood-cocks, field-fares, and other similar birds of passage, indicates that the succeeding winter will be cold. The early arrival of the cuckoo in spring, indicates that the following summer will be hot. An abundance of blossoms on the broom and almond tree, foretells an abundant harvest; and an abundance of haws and acorns, foretells a long and severe winter.

"Mark well the flow'ring almonds in the wood,
If od'rous blooms the bearing branches load;
The glebe will answer to the sylvan reign,
Great heats will follow, and large crops of grain."

An old Scotch proverb says, "A green Yule makes a fat kirk-yard;" and alludes to the sickliness of a mild Christmas to both man and beast. Among other old proverbs, characterising the prognostics of the seasons, and worthy of attention, are the following:—"Hail brings frost in the tail." "A snow year, a rich year." "Under water dearth, under snow bread."

"A January spring
Is worth nothing."

"If Janiveer's calends be summerly gay,
'Twill be winterly weather till the calends of May."

Prognostics most prominent in Upland Districts.—"When there is a copious deposit of dew, and it remains long on the grass,"—says the Rev. James Russell of Yarrow, in reference to a part of Selkirkshire which may be taken as a fair specimen of the inland upland districts of Britain,—"when the fog in the valleys is slowly dissipated by the sun's heat, and lingers on the hills,—when the clouds apparently take a higher station,—and especially when a few cirro-strati appear loose or slightly connected, lying at rest or gently floating along, serene weather may be confidently expected. A change of this settled state is presaged by the wind suddenly rising, by close continuous cirro-strati gathering into an unbroken gloom, and by that variety of cirrus known as the goat's hair or grey mare's tale. Sometimes a few fleecy clouds skim rapidly between the superincumbent vapour and the earth's surface, and are the forerunners of snow or rain. Should the cirri not pass away with the immediate fall, but extend toward the horizon, and present their troubled edges towards the zenith, there will be stormy weather for some time. When a modification of the cirro-stratus is formed to leeward, thick in the middle, and wasting at both ends, with its side to the wind like a ship lying to, it indicates continued wind. After a clear frost, we sometimes see long whitish-coloured streaks of cirrus, whose two extremities seemingly approach each other as they recede from the zenith. This appearance is vulgarly called Noah's ark; and if it point from south-west to north-east, we expect a thaw from the south-west. Small blackish boat-shaped clouds rising in the west, and moving sideways, indicate a thaw, with little or no rain. A short glare of red in the east, about sun-rising, portends a rainy and windy day. When the sky shines from the watery exhalations around the midday sun, rain or snow will soon follow; when it has a green appearance to the east or north-east, frost and snow. A crimson red in the west, after sunset, indicates fair weather; a purple red indicates sleet. Atmospheric changes are more likely to happen a few days after new and full moon than in the quarters. The point when

she changes seems to have little influence; if in the north-west or north-west by west, it is often succeeded by boisterous weather. When her horns are sharp and well defined, we look for frost; when she is whitish and not very clear, for rain or snow. If the new moon seems to embrace the old, very stormy weather is likely to follow. When the wind shifts to the west, after rain from the south or south-west, it generally fairs up, or there are but a few showers. Frost and snow from the south-west are forerunners of bad weather. If the wind turn suddenly from the south-west or south to the north-north-east, while this is accompanied with a smell resembling that of coal smoke, a severe storm will follow.—The lower animals, but such especially as are in a state of nature, or exposed to the open fields, are very susceptible of atmospheric changes. Sheep eat greedily before a storm, and sparingly before a thaw; when they leave the high parts of their range,—when they bleat much in the evening or during the night, we may expect severe weather. Goats seek a place of shelter, while swine carry litter and cover themselves better than ordinary, before a storm. Wind is foretold by the cat scratching a post or wall; and a thaw, when she washes her face, or when frogs come from their winter concealment. The gathering of grouse into large flocks, the diving of sparrows in dry dust, the fluttering of wild-ducks as they flap their wings, the dismal lengthened howl of sea-gulls in an inland place or around lakes, the mournful note of the curlew, the shrill whew of the plover, the *whet-whet-whet* of the chaffinch perched upon a tree, the crowing of the cock at unusual times,—all prognosticate rain or snow. When the field-fare, redwing, starling, swan, snowfleck, and other birds of passage, arrive soon from the north, it indicates an early and severe winter. When gnats bite keenly, when flies keep near the ground (shown by swallows, who feed upon the wing, flying low), we look for wind and rain. But the most wonderful instance of atmospherical changes is upon those creatures that burrow in the ground. The earth-worm appearing in abundance indicates rain. In like manner, the mole seems to feel its approach, as, a day or two before, he raises more hillocks than usual; and when, after a long severe frost, he begins again to work, it will soon become fresh."

"When the wind turns to the north-east and it continues two days without rain, and does not turn south the third day, nor rains the third day," says Shepherd of Banbury, "it is likely to continue north-east for 8 or 9 days all fair, and then to come to the south again. If it turn again out of the south to the north-east with rain, and continues in the north-east two days without rain, and neither turns south nor rains the third day, it is likely to continue north-east for two or three months. The wind will finish these turns in three weeks. After a north wind, for the most part two months or more, and then coming south, there are usually three or four fair days at first, and then, on the fourth or fifth day, comes rain, or else the wind turns north again, and continues dry. If it return to the south in a day or two without rain, and turn north with rain, and return to the south in one or two days as before, two or three turns together after this sort, then it is like to be in the south or south-west two or three months together, as it was in the north before. The wind will finish these turns in a fortnight. Fair weather for a week, with a south wind, is likely to produce a great drought, if there has been much rain out of the south before. The wind usually turns from north to south, with a quiet wind without rain, but returns to the north with a strong wind and rain. The strongest winds are when it turns from south to north by west. When the north wind first clears the air (which is usually once a-week), be sure of a fair day or two."

WEATHER-VANE. An instrument for showing the direction of the wind. See the article Anemoscope. One should be mounted on a conspicuous part of every farmery; and, if of a simple form, it cannot have a neater or more efficient indicator than an arrow, whose dart most readily pierces the wind, and whose butt most facilely and powerfully streams before the wind, and compels the dart to point to the wind's eye. A good contrivance would be four bells of different tones at the four cardinal points of the compass, and a hammer suspended from the dart by a supple spring to strike them; so that a person within any neighbouring house might be apprised by the bell-strokes of every wide veering of wind, and of its direction. The director of almost all the vanes of former ages was a figure of a cock,—an emblem of clerical vigilance; and this has occasioned all sorts of weather-vanes and anemoscopes down to the present day to be popularly called weather-cocks.

WEBERA. A small genus of ornamental, tropical, evergreen, ligneous plants, of the madder family. The corymbose species, *W. corymbosa*, is a native of the upland districts of India, and was introduced to the hothouses of Britain in 1759. It has a height of about 6 or 8 feet, and carries white flowers, and small, black esculent berries. —The tetrandrous species, *W. tetrandra*, is another shrub of the waste lands of India, and, besides producing esculent foliage and esculent fruit, possesses considerable medicinal reputation. Its root is supposed to be anthelmintic; and both its young shoots and its leaves are used as a remedy for bowel complaints.

WECHT. A hand implement for lifting grain. If well made, with a broad slip of ash, and capacious enough to hold at least half a bushel, it is much lighter and handier than any basket; and it may be regarded as an indispensable piece of furniture in all good and extensive barn management. See the article Barn Management.

WEDELIA. A genus of exotic, yellow-flowered plants, of the sunflower division of the composite order. Seven or eight species, varying in height from 6 inches to 4 or 5 feet, varying in adaptation from the open border to the stove, and variously annual and perennial, creeping and tuberous, herbaceous and ligneous, have been introduced to Britain, principally from America; and all thrive in any common soil. The most interesting is the golden, *W. aurea*, a tuberous-rooted frame plant of about 2 feet in height, carrying golden-coloured flowers in August and September, and introduced from Mexico in 1829.

WEED. Any plant which grows spontaneously on cultivated ground. It may be either useless or useful, suitable for cultivation or unsuitable for it, a denizen of the poorest soils or a denizen of the richest ones, a greedy consumer of saline substances or a feeder principally upon air, an indigen of the region which it infests or an introduced hardy exotic,—it may, in short, be a plant of any kind whatever; for it owes its proper character of a weed, not in the slightest to anything in itself, but entirely to its intrusive presence among plants of another kind which are growing or holding possession in the capacity of a crop. Cultivated plants themselves, therefore, are weeds whenever they intrude on one another, or rise on any spot where they are not wanted. Very few weeds are exotics; not many even are imported from very different soils or from considerably distant situations; and the great majority are simple, natural, and perhaps stubborn and persistent inhabitants of the ground where they appear, having been occupants of the very spot itself or of spots in its vicinity before cultivation began, and continuing still to maintain the occupancy as far as cultivation will possibly admit. Yet very many of the most common weeds can be classified into groups according to the soils and situations which they severally love, and are more or less distinct indicators of the constitution or condition of the land on which they grow; and some of these evanish or migrate or supplant one another according to the changes which are made on land by georgy and cultivation. See the article Barren Soils, and the section "The Peculiar Vegetations of Soils" in the article Soil.

Classification of weeds might be made on many principles and in many ways. But one of the most practically useful, having reference to the best systematic methods of keeping them down or extirpating them, is to distribute them into annuals, biennials, and perennials, according to the duration of their roots and to the predominant mode of their self-propagation; another very useful classification, having reference to the degree in which they should be dreaded and the vigour with which they should be kept down, is to arrange them in a list of precedency according to the amount of injury which they do on a farm or of trouble which they give to a farmer; a third very useful classification, which is that adopted in "Holdich's Weeds of Agriculture," and having reference to the manner in which they severally injure crops and trouble cultivators, is to distribute them into such as infest samples of corn, such as cannot be extirpated or long kept down without the aid of fallowing, such as impoverish the soil and encumber crops, such as never rise in the crop or come into the sickle, and such as infest pasture lands; and a fourth very useful classification, or rather selection, having reference to the comparative barrenness or unproductiveness of land, to the indication of the character and condition of soils, and to the suggestion of needful processes of reclamation and georgical improvement, is to distribute them into plants which are liable and ready to overrun so much of the surface of the ground as to render the produce of farm crops of little value, plants which spring up spontaneously among the herbage of sterile or exhausted pastures and meadows, and gramineous plants of harsh, innutritious, or noxious nature which take possession of pastures, downs, moors, bogs, and wastes to the extensive or total exclusion of good grasses. We shall name the principal agricultural weeds of Britain according to each of these four classifications; but of course, we shall do no more than name them, all being described in their respective alphabetical places throughout our work,—and we must neither avoid repetitions under the different classifications, nor attempt a complete list in any part of even one classification.

The principal annual and biennial weeds are wild mustard, *Sinapis arvensis*,—black mustard, *Sinapis nigra*,—wild radish, *Raphanus raphanistrum*,—corn poppy, *Papaver rhœas*,—corn blue bottle, *Centaurea cyanus*,—corn marigold, *Chrysanthemum segetum*,—corn feverfew, *Pyrethrum inodorum*,—sow thistle, *Sonchus oleraceus*,—spear plume thistle, *Cnicus lanceolatus*,—burdock, *Arctium lappa*,—corn cockle, *Agrostemma githago*,—common chickweed, *Stellaria media*,—corn spurrey, *Spergula arvensis*,—goose grass, *Galium aparine*,—small nettle, *Urtica urens*,—red dead nettle, *Lamium purpureum*,—common hemp nettle, *Galeopsis tetrahit*,—sun spurge, *Euphorbia helioscopia*,—climbing buckwheat, *Polygonum convolvulus*,—knotgrass, *Polygonum aviculare*,—hairy tare, *Ervum hirsutum*,—bearded darnel, *Lolium temulentum*,—bearded wild oat, *Avena fatua*,—soft brome grass, *Bromus mollis*,—goose grass, *Bromus secalinus*,—cow parsnip, *Heracleum spondylium*,—viper grass, *Echium vulgare*,—bugloss, *Lycopsis arvensis*,—gromwell, *Lithospermum officinale*—corn woundwort, *Stachys arvensis*,—yellow rattle, *Rhinanthus crista-galli*,—nipplewort, *Lapsana communis*,—goosefoot, *Chenopodium album*,—groundsel, *Senecio vulgaris*,—shepherd's purse, *Thlaspi bursa-pastoris*,—annual grass, *Poa annua*,—and fumitory, *Fumaria officinalis*.—The principal perennial weeds are upright meadow

crowfoot, *Ranunculus acris*,—creeping crowfoot, *Ranunculus repens*,—common buttercup, *Ranunculus bulbosus*,—common ragwort, *Senecio jacobea*,—coltsfoot, *Tussilago farfara*,—daisy, *Bellis perennis*,—great white ox-eye, *Chrysanthemum leucanthemum*,—corn or way thistle,—*Cnicus arvensis*,—black knapweed, *Centaurea nigra* — corn sow thistle, *Sonchus arvensis*,—white dead nettle, *Lamium album*,—broad-leaved dock, *Rumex obtusifolius*,—amphibious persicaria, *Polygonum amphibium*,—great-nettle, *Urtica dioica*,—marsh bent grass, *Agrostis alba*,—common oat-like grass, *Arrhenatherum avenaceum*,—creeping soft grass, *Holcus mollis*,—common wheat grass or couch grass, *Triticum repens*,—mugwort, *Artemisia vulgaris*,—silverweed, *Potentilla anserina*, —bindweed, *Convolvulus arvensis*,—corn mint, *Mentha arvensis*,—horsetail, *Equisetum arvense*,—red eyebright, *Bartsia odontites*,—dandelion, *Taraxacum officinale*,—butterbur, *Tussilago petasites*,—goatweed, *Ægopodium podagraria*,—furze, *Ulex europæus*,—broom, *Spartium serparium*,—restharrow, *Ononis arvensis*,—bramble, *Rubus fruticosus*,—the villous briar, *Rosa villosa*,—the dog rose, *Rosa canina*,—the spiniest briar, *Rosa spinosissima*,—the brake, *Pteris aquilina*,—milfoil, *Achillea millefolium*,—sneezewort, *Achillea ptarmica*,—and various rushes, sedges, ferns, heaths, and mosses.

A list of principal weeds, arranged in the order of the amount of injury which they do on a farm or of trouble which they give to a farmer, would considerably vary in different districts of Britain, in different situations in any one district, and in differently managed farms of similar or even identical character; but the following, corrected from a list in Aiton's Agricultural Report of Ayrshire, and applicable in a general way to the whole of that great, rich, and diversified county, may be taken as a fair average specimen:—The corn thistle, *Cnicus arvensis*, —the spear plume thistle, *Cnicus lanceolatus*,—the marsh thistle, *Cirsium palustre*,—the corn sow thistle, *Sonchus arvensis*,—the annual sow thistle, *Sonchus oleraceus*,—common wheat grass or common couch, *Triticum repens*,—marsh bent grass, *Agrostis alba*,—creeping soft grass, *Holcus mollis*,—stoloniferous bent grass,—*Agrostis stolonifera*,—tall oat grass, *Avena elatior*,—restharrow, *Ononis arvensis*,—sharp-leaved dock, *Rumex acutus*,—broad-leaved dock, *Rumex obtusifolius*,—curled dock, *Rumex crispus*,—common field sorrel,—*Rumex acetosa*,—sheep's sorrel, *Rumex acetosella*,—common ragwort, *Senecio jacobea*,—groundsel, *Senecio vulgaris*,—corn marigold, *Chrysanthemum segetum*,—great white ox-eye, *Chrysanthemum leucanthemum*,—corn feverfew, *Pyrethrum inodorum*,—mugwort, *Artemisia vulgaris*, —coltsfoot, *Tussilago farfara*,—butterbur, *Tussilago petasites*,—sneezewort, *Achillea ptarmica*, —speedwell, *Veronica agrestis*,—field speedwell, *Veronica arvensis*,—corn spurrey,—*Spergula arvensis*,—wild radish, *Raphanus raphanistrum*,—black mustard, *Sinapis nigra*,—charlock or wild mustard, *Sinapis arvensis*,—common chickweed, *Stellaria media*,—silverweed, *Potentilla anserina*, —red dead nettle, *Lamium purpureum*,—stem-clasping henbit, *Lamium amplexicaule*,—common hemp nettle, *Galeopsis tetrahit*,—clown's all-heal, *Stachys palustris*,—corn hedge nettle, *Stachys arvensis*,—horsetail, *Equisetum arvense*,—amphibious persecaria, *Polygonum amphibium*,—common persicaria, *Polygonum persicaria*,—water-pepper, *Polygonum hydropiper*,—climbing buckwheat, *Polygonum convolvulus*,—common fumitory, *Fumaria officinalis*,—field mint, *Mentha arvensis*,—petty spurge or devil's milk, *Euphorbia peplus*,—sun spurge, *Euphorbia helioscopia*,—goosefoot, *Chenopodium album*,—corn poppy, *Papaver rhœas*,—long-headed poppy, *Papaver dubium*,—creeping crowfoot, *Ranunculus repens*, —upright meadow crowfoot, *Ranunculus acris*, —nipplewort, *Lapsana communis*,—earthnut, *Bunium bulbocastanum*,—goose grass, *Galium aparine*,—black knapweed, *Centaurea nigra*,—and great nettle, *Urtica dioica*.

The classification of principal weeds into such as infest samples of corn, such as cannot be extirpated without the aid of fallowing, such as impoverish the soil and encumber crops, such as never rise in the crop or come into the sickle, and such as infest pasture lands, we shall take from Holdich's Weeds of Agriculture, with simply some modernizement of the nomenclature. The principal weeds which infest samples of corn, are darnel, *Lolium temulentum*,—smooth brome grass, *Bromus secalinus*,—corn cockle, *Agrostemma githago*,—four-seeded tare, *Ervum tetraspermum*,—common melilot, *Melilotus officinale*,—wild oats, *Avena fatua*,—goose grass, *Galium aparine*, —shepherd's needle, *Scandix pecten-veneris*,—climbing buckwheat, *Polygonum convolvulus*,—snakeweed, *Polygonum lapathifolium*,—wild mustard, *Sinapis arvensis*,—wild radish, *Raphanus raphanistrum*,—and rape charlock, *Brassica napus*. About one half or so of these chiefly infest wheat, and the rest chiefly infest oats or barley; but they vary much on different kinds of soil, and very seldom do more than two of them occur in one sample of corn. They abound most on light loams and deep loose soils; and sometimes give little trouble on cold clay soils and on the arable lands of fen districts; and often are scarcely known or but very slightly troublesome on light, dry, well-cultivated turnip soils.—The chief weeds which cannot be extirpated without the aid of fallowing, are common couch grass, *Triticum repens*,—creeping bent, *Agrostis repens*, —creeping soft grass, *Holcus mollis*,—smooth-stalked meadow-grass, *Poa pratensis*,—restharrow, *Ononis arvensis*,—corn thistle, *Cnicus arvensis*,—curled dock, *Rumex crispus*,—tall oat-like soft grass, *Holcus avenaceus*,—coltsfoot, *Tussilago farfara*,—corn bindweed, *Convolvulus arvensis*,—corn mint, *Mentha arvensis*,—narrow-leaved stoloniferous bent, *Agrostis stolonifera angustifolia*, —black foxtail grass, *Alopecurus agrestis*,—com-

mon knotgrass, *Polygonum aviculare*,—wild carrot, *Daucus carota*,—hedge parsley, *Torilis infesta*,—fool's parsley, *Æthusa cynapium*,—and fennel, *Anethum fœniculum*.—The principal weeds which impoverish the soil and encumber crops are wild mustard, *Sinapis arvensis*,—black mustard, *Sinapis nigra*,—wild radish, *Raphanus raphanistrum*, —rape charlock, *Brassica napus*,—corn poppy, *Papaver rhœas*,—blue bottle, *Centaurea cyanus*,—stinking mayweed, *Anthemis cotula*,—and corn marigold, *Chrysanthemum segetum*. These abound most on light soils in dry districts, and may generally be regarded as indicating careless, negligent, or unskilful farming; and can be kept down or extirpated only by good husbandry, assiduous tillage, and careful supervision of rising crops.—The principal weeds which never rise in the crops or come into the sickle, but which at the same time so infest or overrun land as to impoverish it, are groundsel, *Senecio vulgaris*,—annual meadow grass, *Poa annua*,—chickweed, *Stellaria media*,—shepherd's purse, *Thlaspi bursa-pastoris*,—spurrey, *Spergula arvensis*,—wild chamomile, *Matricaria chamomilla*,—goosefoot, *Chenopodium album*,—lamb's lettuce, *Fedia olitoria*, —flixweed, *Sisymbrium sophia*,—common fumitory, *Fumaria officinalis*,—and sand mustard, *Sinapis muralis*. These are specially abundant on over-cropped, and scourged and exhausted lands; and when they become plentiful and luxuriant, can seldom be extirpated without summer fallowing and laying down to grass.—The chief weeds on dry, sandy, calcareous pastures or on light loamy grass lands are the dwarf or stemless thistle, *Cirsium acaule*, — common chamomile, *Anthemis nobilis*,—star thistle, *Centaurea calcitrapa*,—great white ox-eye, *Chrysanthemum leucanthemum*, — ploughman's spikenard, *Conyza squarrosa*,—cheese rennet or yellow ladies' bedstraw, *Galium verum*,—wild thyme, *Thymus serpyllum*,—long-rooted hawkweed, *Apargia autumnalis*,—sheep's sorrel, *Rumex acetosella*,—common knotgrass, *Polygonum aviculare*,—yellow rattle, *Rhinanthus crista-galli*, — and common carline thistle, *Carlina vulgaris*. The most formidable of these are the thistles, the sheep's sorrel, and the knotgrass. The chief on loamy, clayey, and damp pastures are yellow goat's beard, *Tragopogon pratensis*,—marsh thistle, *Cirsium palustre*,—melancholy or various-leaved thistle, *Cirsium heterophyllum*,—the meadow thistle or English thistle, *Cirsium anglicum*,—common butterbur, *Tussilago petasites*,—common ragwort, *Senecio jacobea*, — common daisy, *Bellis perennis* — black knapweed, *Centaurea nigra*,—broad-leaved dock, *Rumex obtusifolius*,—common cow parsnip, *Heracleum spondylium*,—several sedges, *Carices*,—and several orchises.

The chief weeds which are liable and ready to overrun so much of the surface of the ground as to render the produce of farm crops of little value, and which serve as indicators of temporary barrenness and as instigators to special diligence and exertion on the part of farmers, are,—corn cockle, *Agrostemma githago*,—common daisy, *Bellis perennis*, — common fumitory, *Fumaria officinalis*, — corn bindweed, *Convolvulus arvensis*, — goose-grass, *Galium aparine*, — corn poppy, *Papaver rhœas*,—broad-leaved dock, *Rumex obtusifolius*,—curled dock, *Rumex crispus*,—groundsel, *Senecio vulgaris*,—common butterbur, *Tussilago petasites*,—colt's-foot, *Tussilago farfara*, —chickweed, *Stellaria media*, — black fox-tail grass, *Alopecurus agrestis*,—sedge, or carnation grass, *Carex*,—stinking may-weed, *Anthemis cotula*,—common couch grass, *Triticum repens*,—corn thistle, *Cnicus arvensis*,—common cow-parsnip, *Heracleum spondylium*, — crow garlic, *Allium veneale*,—mare's-tail, *Hippuris vulgaris*,—cheese rennet, or yellow ladies' bed straw, *Galium verum*,—shepherd's needle, *Scandix pecten-veneris*,—sheep's sorrel, *Rumex acetosella*,—great white ox-eye, *Chrysanthemum leucanthemum*,—corn marigold, *Chrysanthemum segetum*,—black bindweed, *Polygonum convolvulus*,—corn buttercup, *Ranunculus arvensis*,—corn horse-tail, *Equisetum arvense*,—blue-bottle, *Centaurea cyanus*,—wild mustard, *Sinapis arvensis*,—yellow goat's-beard, *Tragopogon pratensis*,—corn mint, *Mentha arvensis*,—tall, oat-like soft-grass, *Holcus avenaceus*, — narrow-leaved stoloniferous bent grass, *Agrostis stolonifera angustifolia*,—common ragwort, *Senecio jacobea*,— black knapweed, *Centaurea nigra*, — ploughman's spikenard, *Conyza squarrosa*, — darnel, *Lolium temulentum*, — wild oats, *Avena fatua*,—smooth brome grass, *Bromus secalinus*,—rest-harrow, *Ononis arvensis*,—dwarf or stemless thistle, *Cirsium acaule*,—and star thistle, *Centaurea calcitrapa*. These plants, besides indicating more or less a bad state of things by their very presence, also show to a considerable degree the comparative fertility or barrenness of land by always being more luxuriant on fertile than on barren soils; and most of them are not at all nice as to either the composition or the condition of land, but will grow with more or less readiness on all kinds of soils.—A list of plants which spring up spontaneously among the herbage of sterile or exhausted pastures and meadows, and also a list of grasses of harsh, innutritious, or noxious nature, which take possession of pastures, downs, moors, bogs, and wastes, to the extensive or total exclusion of good grasses, have already been given in the article Barren Soils.

Some weeds have valuable medicinal properties; a few possess an ornamental character, and lend to the fields and wastes where they grow some of the gentle attractions of the parterre; and many or even most may be applied to some useful purposes of the farm, and made to yield some little compensation for the injury which they have done to the soil or the crops, or for the trouble which they occasion to the cultivator. Sow thistles and some others afford good and grateful food to rabbits and hogs; the cow parsnip is

readily eaten by both hogs and cattle; young thistles, when partially dried, are readily eaten by horses and asses; wild mustard, wild radish, black mustard, and rape charlock, when drawn before they begin to form their seeds, are much relished by cows, and may even be made into hay; and several other of the most common and bulky weeds are more or less agreeable to farm stock, and, when allowed by neglect or oversight to grow in considerable quantity, and cut down in a succulent stage of their growth, may be profitably sent to the forage department of the farm yard. Nettles, ferns, bulky hedge-weeds, and all other coarse, innutritious, or ligneous weeds may be collected for manure, and, according to convenience and quantity, may either be burnt in heaps, with the view of only their ashes being used, or placed in alternate layers with earth and lime in order to undergo slow and steady decomposition and to form a compost. In all cases, however, in which weeds are made to contribute something by way of return to the soil, whether by express use of them as manure ingredients, or by burning them in the course of summer fallowing, thorough care must be exercised to destroy all their seeds and vivacious roots.

A theory has been got up by a few pseudo-scientific agriculturists, that the growth of weeds is beneficial to the cultivation of farm crops, and even essential to the maintenance of fertility in the soil; and this wild theory has been advocated in such strong terms as the following:—"It is no less lamentable than true that, notwithstanding all the splendid talent which has been exhibited from Tull to the present day, this very obvious fact (that all natural vegetation enriches soil) should not have been long ago adopted as a fixed and leading principle in all agricultural and horticultural operations. It stares us in the face in the forests and prairies of North America, the pampas of Buenos Ayres, the dirty summer fallows of England, and everywhere, and in everything. The principle of a clean naked fallow (fortunately a rare occurrence) is utter annihilation. Had farmers and gardeners been able to eradicate weeds, as they are called, the soil would have been a *caput mortuum* long ago. But weeds, like the principles of liberty, destroy, hack, hew, and persecute them as we may, rise again in due time, not to injure, but to fertilize and benefit. To the want of vegetable food is entirely to be attributed the frequent failure of grass, clover, turnips, sainfoin, &c., in England, under the improved system of farming; and the cleaner the land is kept, it is to be suspected, the more they fail. To say the land is tired, proves something is wrong, but explains nothing. We may be quite satisfied that the crops under the old wretched system of farming were much better than under the new, in proportion to the manures, skill, management, &c., applied in both instances. Weeds, misplaced except in summer fallows, were the old farmer's salvation, but he did not know it. Weeds do not rob the soil; they either enable the farmer to do so or prevent him, as the case may be; they keep up the fertility of it; they rob the crops, but not the soil." This piece of declamation—for argument it is not—resembles the shovelling of a load of rubbish into a tilt cart; and the last clause, by a single touch, tilts all back again to the ground. Since weeds "rob the crops," who cares what else they may do? or what common sense farmer will not treat them as "robbers," and kick them out and keep them out as well as he can? "Crops" are all a cultivator cares for,—the sole drift and object of all his labour; and whatever things "rob" them, be they vermin or plants, thieves or thistles, are his enemies, and must be watched and opposed and driven from his farm; and it is just because intruding plants appear among his crops, and therefore rob them, that they are weeds at all. He wishes to appropriate all the available nutriment in a piece of land to the nourishment of crops which he expressly sows or plants upon it,—and he even puts a great deal of extra or artificial nutriment into the land upon the nonce for the due or ample feeding of these crops; so that whatever other plants steal in among the crops, to live upon the land, and devour part of the nutriment, he regards as "robbers" or "weeds,"—their mere presence there constituting them weeds, and their feeding and flourishing there constituting them robbers. Nor can he be reconciled to them by the prospect of their being made by and by to disgorge what they devour, or of their dying on the spot where they lived, and bequeathing their carcases as payment for their food and lodging. Some are voracious eaters of the choicest and rarest ingredients of the food of the cultivated plants, and consequently reiving robbers and downright starvers of the crops; most appropriate much food at the moment, and also hinder the crops from getting ample air and sunshine for the enjoyment of the main body of the food, so that they considerably or largely defeat the objects for which the farmer tilled and fertilized and sowed; and all, before they can be made to give back to the soil what they take from it, give a great deal of trouble, compelling the farmer to spend upon the punishment of *robbers* what could be tenfold more profitably employed upon the nourishing and tending of *productive* plants. Crops and weeds, in fact, are antagonist things,—or at best, the same things in antagonist conditions. Crops are selected or improved plants raised on prepared ground, under the help of artificial appliances, with a view to a maximum produce; and, in so far as they either need or can receive assistance from other plants, they can economically obtain it only on one or two or all of three antecedent principles of ordinary manure, green manure, and rotation of crops, and never on the absurd, starving, contemporaneous principle of sharing with them bed and board. Plants are

weeds only when they "rob" crops, or intrude upon them; and are not weeds at all where no crops are grown. There are no weeds in prairies and pampas and natural forests. Everything there luxuriates in wildness; and the most powerful plants take possession, and keep it, at the expense of the weaker; and any two or six or ten of similar strength, or co-ordinate habits, or tastes for different elements of food may exist together,—and die down in successive generations only to enrich the land, with the help of exuviæ and bird-droppings, and of ammoniacal rains and disintegrating action and chemical agency, for the use of sturdier and more stalwart future races. Nothing is removed from the land by human harvestings; and a perpetual fertilization is going on. Yet even on prairies and pampas and cleared natural forests, with a soil continually enriched and never once cropped during four thousand years, and possessing such a store of phosphatic, nitrogenous, and other rare saline principles as might grow thirty successive crops of wheat without aid from artificial manuring, all the rank herbage must be cleared away and kept away in order to the obtaining of cultivated produce; and no man but an idiot or a maniac would, either with or without tillage, throw seed wheat upon them in expectation of getting the best possible crop of wheat in company with their rankest possible growth of herbage. When cultivation begins, wild vegetation must end; or when crops are at a maximum, weeds are at a minimum. Even too where cultivation was never attempted or has long been abandoned, and where natural vegetation has had as ample scope to do its utmost as on the richest of the prairies or pampas or natural forests of America, if the subsoil be not duly porous, and if the soil and the situation be either too moist or too dry, fertilization has its limits, and a very different process sets in. What shall be said of the bogs and morasses of Europe, the vast fens and savannahs of America, the moors and heaths and wilds of many famous old uplands of Asia, and the arid deserts and burning sands of Judea and Idumea and Mesopotamia? All these were once good and productive territories,—grateful to flocks or fit for the uses of the husbandman; and now, after revelling for centuries or millenniums amid all the glories which 'weeds' or wild plants could give them, they are truly and all over one hideous *caput mortuum*. We have somewhere said in some former article, and we here say again, that the man who imagines weeds to be beneficial to crops ought by all means to sow thistles and docks and to get them up into luxuriance, as the best possible preparation for wheat.

"All plants which grow naturally among a crop that has been sown," remarks Sir John Sinclair, "may be regarded as enemies to that crop. The destruction of such plants, therefore, must be considered as one of the most important branches of the agricultural art; for if that is neglected, or even but slovenly performed, the crops may be reduced to the amount of one-fourth or one-third of a fair average crop, even upon the very best soils. Besides, it merits consideration, that if weeds are suffered to exist, the full advantages of manuring land, and many other improvements, can only be partially obtained. Nor is this all; the mixture of weeds in the soil prevents the crops from receiving the beneficial influence of the atmosphere, —sucks up that moisture so essential for the growth of the crop sown,—tends more than any other circumstance to injure the crop when lodged by violent winds or heavy rains,—augments the risks at harvest (for a crop that is clean, may be ready for the stack-yard in much less time than is required to harvest it, when encumbered with weeds),—and the seeds of these intruders deteriorate the quality of the grain. Notwithstanding all the injuries thence sustained, how many are there, who hardly ever attempt to remove weeds in an effectual manner? This negligence is the more to be blamed, because, were farmers at the trouble of collecting all sorts of weeds, before they have formed their seeds, and of mixing them with rich earth, with lime, or fermenting them with dung, they would soon be reduced into a soft pulpy mass, and in this way, a pernicious nuisance might be converted into a valuable manure.—Various experiments have been tried, to ascertain the positive advantage derived from carefully weeding one part of a field, and leaving another part undone; among these, the following, made with peculiar accuracy, may be safely relied on:—1. Seven acres of light gravelly land were fallowed, and sown broad-cast; one acre was measured off, and not a weed was pulled out of it; the other six were carefully weeded. The unweeded acre produced 18 bushels; the six weeded acres, 135 bushels, or 22½ per acre, which is 4½ bushels, or ¼ more produce in favour of weeding.—2. A six acre field was sown with barley, in fine tilth, and well manured. The weeding, owing to a great abundance of charlock, cost 12s. per acre. The produce of an unweeded acre was only 13 bushels; of the weeded, 28. Difference in favour of weeding, 15 bushels per acre, besides the land being so much cleaner for succeeding crops.—3. Six acres sown with oats; one acre ploughed but once, and unmanured, produced only 17 bushels. Another six acres ploughed three times, manured, and weeded, produced 37 bushels. This experiment proves, that oats require good management, and will pay for it as well as other crops. Ten bushels of the increased produce may be fairly attributed to the weeding; and the other ten to the manure.—The importance of weeding, both to the individual and to the public, is such, that it ought to be enforced by law. At any rate, a regulation of police, for fining those who harbour weeds, the seeds of which

may be blown into their neighbours' ground, can have no injustice in principle. In England, the petty constable might be required, by precept from the high constable, to give in presentments to the Quarter-Sessions, containing a list of all persons who suffered weeds to run to seed in their hedges or lands, such presentments to be particularly specified to the court. Those referring to the coltsfoot, to be given in at the Ladyday sessions; and those referring to thistles, rag-weed, &c., to be given in at the Midsummer sessions. An order of court might then be made, for the immediate removal of such nuisances; and if not complied with, the offender should be fined a sum not exceeding five pounds, one half to the informer, and the other half to go for the relief of the poor. If, in consequence of such a system being enforced, from four to five bushels of wheat, fifteen bushels of barley, and ten bushels of oats additional, were raised in all the fields in the kingdom, whose crops are injured by weeds, the benefit would be well worth the labour and expense, and the farmers would soon find, that however anxious they may be to have their lands tithe-free, yet to have them weed-free is of still greater importance. On the whole, keeping his land in a clean state ought to be a principal object with every farmer; and if this be not carefully attended to, he may rest assured of paying dearly for his neglect. But the losses which he suffers, do not remedy the injury which the public sustains from his slovenly conduct."

"In several countries," says the same writer, "the legislature has interposed its authority for the destruction of weeds. By a regulation in France, a farmer may sue his neighbour, who neglects to destroy the thistles upon his land at the proper seasons, or may employ people to do it at the other's expense. In Denmark, there is a law to oblige the farmers to root up the corn marigold, *Chrysanthemum segetum*. But the oldest regulation for that purpose, was probably in Scotland; a statute of Alexander II. about the year 1220, having been directed against that weed, which was considered to be peculiarly pernicious to corn fields. The statute is very short, and ably expressed. It denounces that man to be a traitor, 'who poisons the king's lands with weeds, and introduces into them a host of enemies.'—Bondsmen who had this plant in their corn, were fined a sheep for each stalk. Under the authority of that law, Sir William Grierson, a Scottish baron, was accustomed to hold *Goul* courts, for the express purpose of fining the farmers in whose growing crops three heads or upwards of that weed were found. Such a plan, if generally adopted, would soon extirpate weeds; and as by a clause introduced into many leases, (and which ought to be universal,) the landlord is empowered to cut down these weeds, at the expense of the tenant, if the latter neglect to do it himself, it is much to be regretted that so useful a regulation should not be generally enforced. The policy of some legislative provision for this purpose has been frequently suggested. A clause enforcing the extirpation of weeds, in hedges, along the sides of roads, passed the House of Commons, but was thrown out by the Lords. It is to be hoped, that so useful a measure, even on a more extensive scale, will soon be passed into a law. By some it is recommended, that the destruction of weeds on the sides of roads should be done at the parish expense; others, by the road-surveyors, and the expense to be stated in their accounts." In some of the best farmed parts of the Continent, the authorities not only order the weeds on commons, public lands, and all road sides to be cut down, but also order all the leaves of trees infested with caterpillars to be stripped off and destroyed; and if individuals neglect to keep down weeds and prevent the multiplication of noxious insects at the proper seasons, the parishes do them and charge the individuals with the expense,—and if the parishes neglect them, the districts do them and charge the parishes. Some similar law in Britain, with reference especially to all annuals and all light-seeded perennials, would evidently confer vast benefit on agriculture, and make a great addition to the national wealth,—not only increasing the produce of field crops, but appreciably diminishing the amount of farm labour, and correspondingly cheapening the market value of farm produce.

The prevention of weeds by several means which are fully in every farmer's own power, and which ought to hold a recognised place in the routine processes of every farm, is vastly more important than even prevention by the authority of some public law. All farmers, according to the nature of their practices, are either preventers or encouragers of weeds. One very effectual measure of prevention is to use care that all seeds of corn, brassicas, or other field crops sown upon a farm be perfectly free from intermixture with the seeds of weeds; for even a very small amount of intermixture,—such as may be found in many a market specimen of agricultural seeds, and such as will readily escape the observation or suspicion of a slovenly farmer —will, in some instances, produce an appalling quantity of weeds, and may so sadly befoul the very cleanest land that years of labour may be requisite to remedy the evil. Another measure of much consequence is to use care that no rubbish or sweepings or offal containing the live seeds of weeds be allowed to find its way to the farmyard or the dung-heap; for weeds of many kinds, comprising some of the most mischievous, when they go into a field through the medium of manure, take such stubborn possession as to resist all but the sturdiest and most persevering efforts for their extirpation. A third precaution is to keep the sides of fields, the sides of hedges, the sides of roads, and all waste or rubbishy spots about a farm in a clean condition, and on no ac-

count to allow any weeds there to run to seed; for however much stray seeds are brought in by strong winds from neighbouring or comparatively distant places, the grand supply for the propagation of new races of weeds is always furnished within a farm's own limits. Another important precaution, though properly but a subdivision of that which we first named, is to use only such grass-seeds as have been raised upon the farm itself, and saved from a very cleanly crop, or at least not to use any which have been imported from the Continent, or obtained from any unknown party in Britain; for the grass-seeds commonly sold in the market, particularly the seeds of rye-grass, often contain intermixtures of weed-seeds which cannot readily be detected by the eye, and which sometimes so sadly befoul comparatively clean land that after it has lain years in grass, and is broken up again for tillage, a vast quantity of weeds of different kinds formerly unknown upon it rush up in mixture with the first crop, and occasion great loss and trouble, And a fifth precaution, more important far than any of the rest, is to work well a wise system of rotation. "Upon every farm where steady and judicious management is exercised," says the writer formerly quoted, "weeds of all kinds may easily be kept under at a moderate expense, provided regular rotations of crops are strictly adhered to, and care used to prevent weeds from securing an effectual lodgment in the soil. Upon all clay soils, or those that are most infested with perennial weeds, summer fallow is the radical mode of destroying these adversaries; and if this mode is resorted to once in six years, and carried into execution with accuracy and precision, any injury from weeds, during that rotation, will be of small importance. But upon light soils, independent of the ordinary ploughings, harrowings, and rollings, the horse and hand hoe must be used as often as possible, to keep down and destroy the numerous host of foes, with which such soils are infested; and if these operations are duly attended to, much injury cannot be sustained, even upon the richest or driest soils, from the attack of weeds, whether of the annual, biennial, or perennial varieties."

"Though it is impracticable to extirpate annual weeds altogether, either by summer fallow or turnip culture, yet the number of weeds may be so much lessened, by these means, as to prevent them from materially injuring corn crops. Two measures are necessary for that purpose,—first, to bring the seeds within the limits of vegetation,—and secondly, to destroy every weed that vegetates, thus regularly lessening the original stock. As the seeds of annual weeds are naturally furnished with the means of preservation while stored in the ground, it is absolutely necessary to bring them into life, before their destruction can be effected. This is accomplished by the operations of ploughing, harrowing, and rolling, by which the ground is pulverized and reduced, whilst the seeds are brought to the surface, or so near it as to allow their speedy vegetation. All the seeds within two or three inches of the surface, may be expected to vegetate according to circumstances, such as, richness of soil, fineness of mould, and the degree of moisture which may prevail when the above processes are executed. When the first crops of weeds appear above the surface, a second ploughing should be given, by which that crop will instantly be destroyed, and a foundation laid for producing another crop. Harrowing and rolling should again be resorted to; and in this way, several crops may be annihilated, in warm and moist seasons, before the turnips are drilled; more especially if attention has been paid to harrow and roll the land after every ploughing, so that sufficient moisture may be preserved to insure vegetation. When under turnips, both the hand and horse hoe should be constantly employed whenever weeds appear; and upon no account should a single one be allowed to run to seed. By paying due attention to these measures, many farms which formerly were a nest of seed-weeds, are now brought into such order that the weeds are kept under subjection and easily managed. In this way the destruction of many annual weeds may be accomplished, before the turnip-seed is sown, and the seeds of almost every annual weed, locked up in the ground, may be brought to the surface, and within the reach of vegetation. Besides, the several horse and hand hoeings given to the turnip crop, serve to destroy every annual weed as fast as it appears; and if the seed-furrow given the corn crop which succeeds the turnips, is not taken deeper than the horse-hoeing furrow, (and a greater depth is unnecessary,) few weeds will appear in the corn crop which afterwards follows. As grass-seeds are always sown in the improved districts, with the corn crop that succeeds turnips, no annual weeds can appear in that season; but it very often happens in the succeeding year, from ploughing the clover stubble a little deeper than the seed-furrow given to the crop which succeeded turnips, that a fresh growth of annual weeds make their appearance. To get the better of these enemies, some experienced farmers have hand-weeded the crops which followed clover, at an expense not less than from ten to twenty shillings per acre, and evidently much to their advantage; whilst others have resorted to the drill husbandry to get quit of annual weeds. The great object of both was, to procure clean crops, each being perfectly satisfied, that if their crops were full of weeds, the productive powers of the soil would not only be deteriorated, but that the amount or value of those crops would be also considerably lessened.

"Owing to the nature of the soil and climate, many perennial weeds are much more abundant in Scotland, and also in Ireland, Wales, and the north and north-west of England, than in other

countries, where the soil is drier, and the climate more temperate. So far as respects couch-grass, there is no other way of getting rid of it, than by picking and gathering every root during the summer season, when the land is in preparation for turnips, or when the radical process of summer fallow is executed. The same observation may be made with regard to knot-grass, which, though not so general as couch, must be regarded as a most hostile adversary to improved husbandry. To get rid of these weeds, many farmers have employed girls with baskets to follow their ploughs, and to pick up every root as fast as it was turned up. A practice of this kind certainly deserves commendation; for were it steadily followed, the country would soon be freed from these destructive roots. In short, attention to the gathering of couch and knot grass must never be relaxed, otherwise these enemies will soon regain their primitive strength; but if that attention is constantly bestowed, the labour of every rotation will become more easy in the execution, and the expense will in a proportional degree be lessened. With regard to docks and thistles, the method of getting rid of them is perfectly obvious; all that is required being to fallow the ground well in the first instance, and to exterminate the plants afterwards whenever they appear. This may be accomplished by pulling them up by the root, in every corn-field, when the weather is moist, and cutting them over in all the grass lands before they have perfected their seeds; though cutting should only be resorted to when the weather is so dry as so prevent pulling these weeds out of the ground. The same attention ought to be paid to the destruction of nettles, ragweeds, mugwort, and the mountain daisy. Every one of these weeds ought to be pulled up by the root, if that measure can be accomplished; but where that is impracticable, they ought to be regularly cut down by the scythe, in which way their increase will at least be prevented. This operation should always be performed before their seeds arrive at maturity, otherwise the ground may thence be stocked with fresh seed, to an extent not much less than if the cutting process had been neglected. As to tussilago, the best time for destroying that plant, is, in the months of September and October, after the crops are cut, at which season the plants are at their full growth, and easily discovered. The method then to be used is, to pull up and carry off every stock or root that can be laid hold of; and it will be observed, by inspecting the roots at about an inch below the surface, that a number of buds, about the size of a pea, spring from that part of the root, which flowering, afterwards produce fresh seed. If these are allowed to stand till next spring, they will flower, and shed their seeds in spite of every possible attention, the flowers coming out early in April, according to the season; so that it is impracticable to prevent their increase by any other method than the one suggested. If this plan, however, is persevered in for a few years, success is indisputable; though it must be remarked, that much depends upon performing the operation of pulling, as early as the crops are cut,—for if delayed for any length of time, the leaves wither and fall off,—after which the roots cannot easily be discovered. If the weather is moist, there will be little difficulty in pulling up the roots to a sufficient depth; but should it be dry, or the ground hard, it is proper to furnish the pullers with a small piece of iron, split at the one end like the toes of a hammer, and about ten inches long, to enable them to get the root up from the required depth. A few boys or girls, under the direction of a careful overseer, will execute this work at a trifling expense; and care must be taken, that all the roots so pulled be carried off and destroyed, for, if allowed to remain at the sides of stone-walls or hedges, they will flower in the succeeding spring, and shed their seeds; which, being of a winged description, will fly about the field in all directions. Where land is much infested with this pernicious weed, it is proper to examine it in the spring months, lest any of the stalks should have been missed in autumn; and in this way, by attention and perseverance, ultimate success may be relied on. With regard to crowfoot, it is only to be destroyed by fallowing the land completely during dry weather. By that means, this baneful weed is easily destroyed; but if the season is wet, hand-picking must be resorted to, otherwise fields infected with it will only be partially cleaned. Briars and brambles are likewise injurious to arable lands; and their roots being placed below the operation of the plough, they cannot be pulled up. To get rid of them, they must be dug out with great care. On grass lands, the seeds of furze or whins, and of broom, more especially where the soil is of a soft nature, are also troublesome. They should be pulled up in the state of seedling plants, when the land is saturated with moisture, which can easily be effected."

WEEDING. See Weed.

WEEVIL. The snouted family of hard wing-cased beetles. It is one of the most destructive families of insects which plague the cultivators of the soil and the owners of agricultural produce; and possesses a manifold, searching, and melancholy interest, in particular, to farmers, practical gardeners, corn-merchants, maltsters, and foresters. Its characters are well defined, and enable a very superficial observer readiy to distinguish its species from those of all other families, except perhaps the wood-eaters. See the article Bostrichidæ. The snout or rostrum of a weevil is its grand characteristic; and this, in all cases, is an anterior process or projection, more or less elongated,—and does not consist of the parts of the mouth as in flies and other suctorial tribes, but is an extension of the head, having the usual oral organs situated at its ex-

tremity. The body is usually more or less arched lengthwise, and in many instances approaches to pear-shaped, with the thicker or hinder end somewhat acuminated; but in other instances is nearly cylindrical, and narrowed at each end The external crust is generally very hard, and well fitted to resist the injuries to which the insects would otherwise be exposed from the nature of their haunts, which are frequently among stones and loose earth. Such species, however, as live exclusively on plants, have often a softer integument, and are not unfrequently adorned with very beautiful colours, occasioned by a coating of minute scales. Few weevils are much observed on the wing; for, like the majority of the beetle-race, they fly but imperfectly; and many which confine themselves to the surface of the ground have their wing-cases soldered together at the suture, and are incapable of raising them. Another very distinctive mark of the whole family, is furnished by the antennæ, which are inserted on the rostrum, and commonly consist of eleven joints, the radical one of which is nearly as long as all the rest taken together, and is received into an oblique groove on the side of the rostrum; and the articulated portion, which is clavate at the apex, usually forms a right angle with this stalk or elongated radical joint, so that when the antennæ are extended, they present the appearance of a trident, of which the rostrum forms the central prong. Weevils composed the genus *Curculio* of Linnæus; but as they are very numerous, and exhibit almost endless modifications in form and structure, they have been distributed by modern naturalists into a multitude of genera. Not fewer than five hundred species have been described as inhabiting Britain. Both in the larva and perfect states, they feed exclusively on vegetable substances, principally on herbaceous plants, although no small numbers likewise attach themselves to trees and shrubs; and as a whole, they are very formidable enemies to both the farmer and the gardener. The larvæ of certain kinds are subterranean, and consequently consume roots; others destroy the flowers of fruit trees; and some feed upon seeds, while the perfect insects mutilate the leaves. Some of the best known and most mischievous species are noticed in the articles Calandra, Anthonomus, Phyllobius, Balaninus, Otiorhynchus, Apion, and Hylobius; but many species which are known or suspected to inflict great injury have as yet been very imperfectly observed.

Two species recently written into notice by Mr. Curtis have been ascertained to work prodigious havoc upon leguminous crops.—The worst of the two is called popularly the striped pea weevil, and scientifically *Sitona lineata*, or *Curculio lineatus*. It is elliptical in form and convex above, punctured and clothed with minute scales; and has more or less an ochreous or light clay colour, but, after losing its scales by age or accident, displays a black shining surface. The head is elongated and deeply punctured; the face is concave, and has a channel down the centre; the snout is short, stout, and notched; the eyes are lateral, prominent, orbicular, and black; the antennæ arise out of deep angular grooves toward the tip of the snout, and have a tawny colour and a fusiformly clubbed extremity; the thorax is deeply punctured, broader than the basal part of the head, and convex on the sides; the wing cases are broader than the thorax, elliptical, rounded at the apex, and finely punctured in the manner of striæ, with tints of alternately lighter and darker clay colour; the wings are very ample, and folded beneath the elytra; the six legs are ferruginous, short, and stoutish, and the tarsi or feet are four-jointed. The other species is called popularly the spotted pea-weevil, and scientifically *Sitona crinita* or *Curculio macularis;* and differs from the preceding principally in being of smaller size and of different colour. The head and body are predominantly black and shining, with a clothing or armature of greyish or rosy-tinted scales or short hairs; the thorax is marked with four dark stripes; and the elytra are rather rough, and have short bristles behind.—The spotted species chiefly devastates pease, but the striped devastates also beans, lucern, and clover; and both either destroy the plants as soon as they rise above the surface, or nibble the leaves and notch the edges as soon as they have expanded. Their habits of propagation, the economy of their larval and pupal states, and the surest methods of destroying them, are but very obscurely known; yet the following notices by Mr. Curtis of devastations done by the striped species, and of the likeliest methods of keeping down both species, may be acceptable and useful.

"Most farmers are very imperfectly acquainted with the economy of these insects; and it was a long time before gardeners could be convinced that it was a weevil which caused them so much anxiety. Some very naturally accused the sparrows; traps were set for rats and mice; lime strewed for slugs and snails; and toads were encouraged to extirpate the woodlice; but still the crops kept disappearing, as none of these precautions affected the wary enemy in his coat of mail. There were, however, both gardeners and farmers, whose close attention to the operations of nature, united with steady perseverance, which generally leads to the truth, who eventually succeeded in detecting the real cause of the mischief. In favourable seasons the weevils make their appearance at the end of March; but April is the month when they are most destructive to the pea-crops, — and one then finds that healthy shoots are daily, if not hourly, disappearing in a most marvellous manner, without any apparent cause, so that spaces of a foot in length, and sometimes the entire rows, are lost, or the few that may be left are so weak that the produce can be reckoned of little value. The year 1844,

if I may judge from the number of communications transmitted to me, appeared to be well suited to these weevils, which were actively at work in thousands in the vicinity of Hertford at the end of March, continuing their operations for a fortnight, and entirely eating off the second and third sowing, when the plants had grown from two to four inches high. At this period of the year, they issued from the ground from 9 to 10 o'clock in the morning, to feed all day upon the pease; and they retired under the clods of earth on the approach of evening. They were equally troublesome at Stafford the first week in April, when they ate off the early pease; and in the Isle of Wight these weevils were not less destructive, for there they attacked the beans as well. On the 30th of the same month, I received from Mr. Pusey an interesting account of this beetle, communicated by Mr. Robert Baker, stating that some garden marrowfat pease were drilled early in February, which were retarded in growth from the cold north-east winds and wet, and destroyed by the ravages of this insect, which notched all the leaves, and in many instances entirely defoliated the stem. It most abounded on light turnip-soil. Mr. Baker correctly observes that 'it is exactly the colour of the soil, and very difficult to detect, as upon the approach of any one, it falls down suddenly from the pea, and lies motionless for some time afterwards, as if dead; but if any one looks attentively forward a few yards, they may be observed in scores sitting upon the edges of the pea-leaves and gnawing away earnestly, with appetites as voracious as the turnip-fly, and almost as destructive in the result.' From the same source we learn that 'they do not attack the common hog-pea so vigorously as the garden varieties; but the marrowfat and early pease suffer most.' This was corroborated by the fact that the maple-grey pease nearly escaped, whilst the remainder of 8 acres in the same field were obliged to be ploughed up. It is somewhat remarkable that this beetle commences with the pease in March; then it affects the broad beans to such an extent, that I have not been able to find a single leaf in a field of many acres which is not greatly notched; and in August, and until the close of the autumn, its ravages are transferred to the crops of clover and lucern. On the 18th of that month, 1843, I received a communication from Mr. C. Parsons, of North Shoebury Hall, Essex, which is too valuable to be passed over. He says, 'I enclose you a beetle, very destructive in these parts to the young plants of clover, lucern, &c.; so much so, as often totally to destroy whole fields, and especially those of lucern, *Medicago sativa*, which they attack in such a way, that for several years past no one has been able to obtain a full plant, although going to the expense of sowing the land two or three times over. The damage is attributed by our farmers here to the turnip-fly, and the habits of these little weevils render it in the spring of the year exceedingly difficult to detect them, as the moment one approaches near, down they fall upon their backs amongst the clods, and remain motionless with their legs folded up. I have searched a long time in vain for them in fields where they were committing their ravages, in order to convince my neighbours what they were indebted to for the loss of their crops. At this time of the year they are readily enough obtained, as the pease, beans, and other papilionaceous plants often swarm with them. I have a field of pease that does so at this time, the remaining leaves of which they have completely riddled; and when a person walks in amongst them, you may hear a pattering like rain upon the leaves, occasioned by their dropping down. I last year sowed a small piece of lucern in July, that was untouched by them; now, whether at that time they are absent, or whether there is any interval between a first and second brood of them, would be very desirable to know, as we might then perhaps steal a march upon them.' Two years previous to this, viz., the 15th of September, 1841, Mr. William Trenchard transmitted me the following instructive observations from Marsh Farm, near Sherborne, Dorsetshire, which carry forward the economy of the weevils several weeks later:—'Walking along the headland of a field of broad-clover, from whence the barley had been carried about a fortnight, I was surprised to see that throughout, for the width of four or five yards from the hedge, the plant was very much injured, and in many parts quite destroyed, from having been bitten apparently by some insect. Nearly every leaf was eaten round the edges, and so deeply were they indented, that those parts of the leaf not eaten are withered from the sap not being able to ascend. Curious to know by what animal such ravages could have been made (for I suppose the headland is more than half an acre), I examined the clover to discover the depredator, but for a long time unsuccessfully, until at length having stood quite still and watched the leaves intently for a considerable time, I ascertained that it was done by a number of small brown beetles, which immediately, on moving near, hid themselves by getting under the leaves, and on a nearer approach they let go their hold altogether, and fell to the ground as if dead, but immediately recovered and crept among the roots of the clover, where they remained until all was again quiet. Being so exceedingly shy, it was a long time before I could see any of them actually eating, but by perseverance I eventually succeeded in observing several. They attack the edge of the leaf, holding it steady between their legs, whilst they eat down from top to bottom like a silkworm. To give some idea of their numbers, when I moved the clover with my hand or foot, they fell off by dozens.' It still remains to be ascertained where the eggs are deposited. This operation must take place, one would imagine, in the sum-

mer or autumn, unless the weevils hibernate, as they are ready to take the field in the early spring, and in April they abound on the broom and furze in Norfolk, Surrey, &c. It is equally remarkable that we are ignorant where the larvæ feed.

"Ignorant as we are of the early stages of these weevils, the only remedies we can at present apply will be in destroying or annoying them in their beetle state; and from their horny shells and power of contracting and protecting their members, it is difficult to find any application that will extirpate them without injuring the plant. For the garden, I should recommend the tarring or painting two strips of canvas, and placing one on each side of a row of pease early in the morning, and two or three hours after; by shaking the plants the weevils would fall down and be held fast by the adhesive surface. This might be repeated several times each day, until it would be seen that their numbers were sufficiently reduced to secure the crop. Of course the painting or tarring must be repeated whenever it is too dry to fix the objects falling down. Neither soot, wood-ashes, nor lime will injure the weevils, we are informed and can readily believe; yet by dusting over the pease early in the morning with any or all of these powders, whilst the leaves are damp, their food will be rendered so unpalatable that the enemy will be driven to forage elsewhere; and if a row of pease were sown near, which was left undusted, the beetles would resort thither, and when it was clear by the erosion of the leaves that the plague was congregated there, boiling water poured along the line would eradicate them, and thus the principal sowing might be saved; or the tarred canvas might be most efficiently employed, if that plan were preferred. Mr. Baker has found harrowing or hoeing beneficial when a field of pease is attacked by the weevils. It should be done whilst the dew is upon them, that the earth may adhere and make the plants unpalatable; and he says he has found this one of the most successful modes of checking the ravages of the turnip-fly."

WEIGHING MACHINE. A machine for promptly ascertaining the weight of any objects or commodities. The kinds of it in most common use are noticed in the articles Balance and Steelyard; and peculiar kinds, recently invented kinds, and kinds more or less specially adapted to the uses of the farmer, the miller, the corn-merchant, and other parties who deal in agricultural produce, are so numerous that we can afford only to notice a few of the most useful.

Smith's portable weighing machine, invented about 21 years ago by Mr. John Smith of Edinburgh, is a contrivance on the principle of the Roman steelyard for weighing bags or sacks of corn, flour, or other goods. The bag or sack to be weighed is placed on a stand on one side of the machine, which is provided with arms for holding the sack open so as to allow portions of the corn or other goods to be added or abstracted; and its weight is immediately ascertained by putting one or more small weights on a small platform on the other side. The machine, when in working order, stands like a frame upon the floor, but it is provided with an under-support and two small wheels,—and can easily be removed from place to place in the manner of a common wheel-barrow.

The balance weighing machine for sacks of corn, bags of flour, and similar bulks and commodities, presents a general resemblance to Smith's, and has as good or better adaptations to the barn, and possesses similar facilities for holding sacks and for removal from place to place; but it is constructed on the balance principle instead of the steelyard one, and requires an amount of weights equal to the absolute weight of the bodies weighed, and is made in various ways, either chiefly of cast-iron or with a frame-work of wood, and at cost prices varying from £5 to upwards of £8.

The hydrostatic weighing machine was invented by Mr. Milne of Edinburgh, and indicates the weight of a body by the rise of a column of mercury. A cylindrical cistern containing mercury communicates with a small tube, having attached to it a graduated scale; a loose piston floats on the surface of the mercury in the cistern; and a scale-board is attached to the piston-rod. Any body placed on the scale-board causes the piston to sink in the mercury, and to displace a portion of it equal to the body's weight; and the displaced portion rises round the sides of the piston proportionally to the quantity displaced, and also rises to a proportional height in the tube, and thereby indicates the absolute weight of the body on the graduated scale.

The weighing machines of Mr. James of London are constructed on a peculiar principle, and possess a wonderful variety of forms and adaptations. Their scale-boards do not rest upon a system of levers, as in the common forms of machines for weighing heavy bodies, but are suspended from the extremity of the beam, as in the ordinary balance, and at the same time are free from all embarrassment by chains or cordage. These machines obtained prizes from the French Government, and from the Highland and Agricultural Society of Scotland, and from the Royal Agricultural Society of England; and the report of the last of these says respecting them: "It would require more space than can be devoted to this subject to explain the causes of error incident to all weighing machines hitherto made, and from which Mr. James's are free. The principle is mathematically correct, and mechanically carried out, as is proved by placing the object to be weighed on any part of the scale-board, when it will be found to be balanced by the same weight. Scale-boards of the largest dimensions may be used; and it is hoped that

by means of this invention agriculturalists will be induced to ascertain the relative value of varieties of food in the fattening of cattle, by frequently placing them on the weighing machine; which will indicate the weight of the largest ox or loaded cart, with as much accuracy as the sack of corn or still lighter objects." The principle of these machines admits an unlimited multiplicity and variety of form, adapted to every possible commercial exigency, and also, by combination with various mechanical powers, produces machines which, while accurately serving every purpose of weighing, are at the same time perfect cranes, crabs, or turn-tables. The more prominent advantages of the invention are economy of first cost, the price being less than that of a common beam with its necessary appendages,—economy in time and labour during the operation of weighing,—durability, the machine seldom requiring adjusting, and admitting of the roughest usage without injury, and the centres not being exposed to wear and tear, except during the act of weighing,—the admitting of a greatly extended scale-board, without proportionally enlarging the size of the machine,—and the presence of an indicator or cock as in the common beam.—One form is a twenty hundred weight machine for weighing hay, straw, oil-cake, or any other description of agricultural produce; and it may have a moveable pen connected with its scale-board, rendering it applicable to the weighing of calves, sheep, and hogs, and also to the weighing of such loose articles as potatoes, turnips, and mangel-wurzel.—Another and somewhat similar form is provided likewise with a sliding frame for increasing the size of the scale-board at pleasure, so as to adapt it to the weighing of such bulky articles as hops; and has also an upright rod at the back of the scale-board, furnished with two small chains and hooks, for conveniently weighing packages of wool; and may further be constructed with a chain-enclosed pen for weighing sheep.—A third form, not far from akin to the preceding, has a large scale-board, or high pen, and ascents to the scale-board, for the weighing of cattle.—A fourth form is a five hundred weight machine for weighing by fractional parts. One pound in the small scale-board is equal to eight pounds in the large, so that to weigh one hundred weight of goods it is only necessary to place fourteen pounds on the small scale-board. By this means a considerable saving is effected in the purchase of weights, and weighing operations are conducted with great quickness, and much less labour.—A fifth form is a three hundred weight machine, with a rising back, for weighing sacks and sackfuls. The rising back may be adjusted to any required height; and two arms project from its top, furnished with hooks at their extremities, for keeping open the mouth of a sack.—A sixth form is near akin to the preceding, but has the scale-board so attached to the rising back that it may be raised to the height of a man's shoulder, or to that of a cart or waggon, so as to allow a weighed full sack to be shifted with great facility; and this form, independently of its convenient character as a weighing machine, is in fact a mechanical contrivance for raising full sacks to a convenient height for removal, with half the usual amount of labour required for lifting them from the ground to the shoulder or to a cart or waggon,—and it is therefore peculiarly suitable for farmers and millers.—A seventh form is a three-hundred weight pedestal machine, exceedingly desirable for domestic purposes, or for situations which require the combination of elegance with utility. Its exterior appearance is that of an ornamental piece of furniture, similar to the pedestal of a statue, or a quadrangular, pannelled, corniced, high, and narrow chest; its top, which forms the good's scale board, may be in marble if required, and will then serve as a handsome and useful small table; and its weighing apparatus is enclosed and completely hid from view. This form is eminently suitable for a large kitchen dairy; and it may also be provided with a moveable support for weighing sacks.—An eighth form is a machine with an even beam, with two scale boards of equal size, and with the beam-arms of equal lengths; and it is used in the same manner as the common balance, yet is so constructed as to have no embarrassment from chains or cordage, and as to be capable of all the advantageous peculiarities and adaptations of the seven forms which we have previously described,—particularly rising backs, enlarging and rising scale boards, pens, and hooks and arms.—A ninth form weighs on the principle of the steelyard, and also comprises rising backs, enlarging and rising scale-boards, and other conveniences similar to those already noticed.—A tenth form is a dial weighing machine without springs, simple, accurate, and delicate. A number of goods or a multitude of separate bodies are weighed by it with great rapidity; and as it requires no weights, the labour of shifting them, and the annoyance so frequently occasioned by losing or mislaying some of them, are entirely avoided; and, like all the preceding forms, it admits of any arrangement of the scale board.—An eleventh form is a weigh bridge, constructed on the parallelometal principle, ensuring great accuracy of result, with little or no liability to go out of repair; for when the bridge is not in use, it does not rest upon its centres, and therefore cannot be injured by any amount of traffic passing over it.—Other forms are different kinds of weighing cranes suitable for granaries, warehouses, docks, wharves, and railways, or indeed for any places and purposes where heavy goods or objects require to be both lifted and weighed. The construction of these cranes is exceedingly simple; the positions of the jib, winch, chain-break, and other parts of the ordinary crane, are in no way altered; nor are the movements of the crane at all obstructed.

They may be used as weighing machines, or as cranes at pleasure, a simple turn of the hand being all that is required to render the jib either fixed or vibratory. The length of the chain, or of the jib, and the weight which the cranes may be required to raise and weigh, or the purposes for which they are intended, are matters of no moment. In landing and weighing heavy goods, the weight is ascertained with all the accuracy of the beam while the goods are in a state of suspension, and the loss of time, labour, and expense, occasioned by shifting them from the crane to the beam, and back again from the beam to the crane, are entirely avoided.

WEIGHTS. In the article MEASURES we have given an account of the reformation of the English measures. The following tables exhibit the relations of some of the most important measures of weight.

1. *French Measures of Weight.*—The unit used in weighing is the kilogramme. It has been fixed by law, and is equal to the specific weight of the distilled water contained in one cubic decimètre. The kilogramme thus fixed was found to be equal to 2 livres (pounds), 5 gros, 35 grains, $\frac{15}{100}$ poids de marc, and to 2 lbs. 8 oz. 3 dwt. 6·355 grains troy, or 2 lbs. 2 oz. 4 drams, 16 grains avoirdupois weight, English. As the most common things of daily consumption are sold by weight in small quantities, a great difficulty arose in introducing this part of the system; and the old denominations of weight have therefore been allowed to remain, with some modification in their actual value, taking the kilogramme as the basis. The kilogramme is divided into 2 livres; the livre is subdivided into 16 ounces, the ounce into 8 gros, and the gros into 72 grains. This new livre, therefore, exceeds the old one (poids de marc) by $\frac{3}{100}$; so, to reduce kilogrammes into old measure, it is necessary to multiply by 2 and add $\frac{2}{100}$.

English Troy.	*French.*
1 grain (1-24th of a dwt.) - - =	0·06477 gramme.
1 pennyweight (1-20th of an ounce) =	1·55456 gramme.
1 ounce - - - - - - =	31·0913 grammes.
1 pound troy imperial - - - =	0·3730956 kilogramme.

English Avoirdupois.	*French.*
1 dram (1-16th of an ounce) - =	1·7712 gramme.
1 ounce (1-16th of a pound) - =	28·3384 grammes.
1 pound avoirdupois imperial - =	0·4534148 kilogramme.
1 hundred weight (112 pounds) =	50·78246 kilogrammes.
1 ton - - - - - - =	1015·649 kilogrammes.

1 millier = 1000 kilogrammes (weight of a tun of sea-water).
1 quintal = 100 kilogrammes.
1 hectogramme = 1-10th of a kilogramme.
1 decagramme = 1-100th "
1 gramme = 1-1000th "
1 decigramme = 1-10,000th "

2. *English Measures of Weight.*—The statute of 5 George IV., c. 74, made some slight modifications in the measures of weight, but retained, in the main, the existing measures. "The troy weight," say the Commissioners of weights and measures, "appeared to us to be the ancient weight of this kingdom, having existed in the same state from the time of Edward the Confessor; and there are reasons to believe that the word *troy* has no reference to any town in France, but rather to the monkish name given to London of Troy Novant, founded on the legend of Brute: troy weight, therefore, according to this etymology, is, in fact, London weight. We were induced, moreover, to preserve the troy weight, because all the coinage has been uniformly regulated by it; and all medical prescriptions or *formulæ* always have been estimated by troy weight, under a peculiar subdivision, which the college of physicians have expressed themselves most anxious to preserve." It was resolved, therefore, to continue the use of troy weight, and also, on account of the accuracy of the troy standard, to raise the avoirdupois weight from this basis. "We found," continue the commissioners, "the avoirdupois weight, by which all heavy goods have been for a long time weighed (probably derived from *avoirs* (*averia*), the ancient name for goods or chattels, and *poids*, weight), to be universally used throughout the kingdom, This weight, however, seems not to have been preserved with such scrupulous accuracy as troy weight, by which more precious articles have been weighed; but we have reason to believe that the pound cannot differ by more than one, two, or three grains, from 7,000 grains troy. It, therefore, occurred to us, that we should be offering no violence to this system of weights, if we declared that 7,000 grains troy should be hereafter considered as the pound avoirdupois." It was accordingly enacted that, from January 1st, 1826, the standard brass weight of one pound troy weight, made in 1758, should be the genuine standard measure of weight, and be denominated the imperial standard troy pound, containing 5,760 grains, and that 7,000 such grains should be a pound avoirdupois.

DIVISION I.—*Avoirdupois Weight.*

27$\frac{11}{32}$ grains - -	= 1 dram - -	= 27$\frac{11}{32}$ grains.
16 drams - -	= 1 ounce - -	= 437$\frac{1}{2}$ "
16 ounces - -	= 1 pound (lb.) -	= 7000 "
28 pounds - -	= 1 quarter (qr.).	
4 quarters - -	= 1 hundred weight (cwt.).	
20 hundred weight	= 1 ton.	

This weight is used in almost all commercial transactions, and in the common dealings of life.

Particular Weights belonging to this Division.

	cwt. qr. lb.	
8 pounds - = 1 stone		used for meat and fish.
7 pounds = 1 clove		
14 pounds - = 1 stone - =	0 0 14	used in the wool trade.
2 stone - = 1 tod - =	0 1 0	
6$\frac{1}{2}$ tod - - = 1 wey - =	1 2 14	
2 weys - = 1 sack =	3 1 0	
12 sacks - = 1 last - =	39 0 0	

A pack of wool contains 240 lbs. A truss of hay weighs 56 lbs., and of straw 36. A stone of glass is 5 lbs.; a seam 24 stone.

8 pounds - = 1 clove, - - -	used for cheese and butter.
32 cloves - = 1 wey in Essex, -	
42 " - = " in Suffolk -	
56 pounds - = 1 firkin - -	

Division II.—*Troy Weight.*

24 grains	= 1 pennyweight	= 24 grains.
20 pennyweights	= 1 ounce	= 480 "
12 ounces	= 1 pound	= 5760 "

These are the denominations of troy weight when used for weighing gold, silver, and precious stones, except diamonds. But troy weight is also used by apothecaries in compounding medicines, and by them the ounce is divided into eight drams, and the dram into three scruples, so that the latter is equal to twenty grains. For scientific purposes, the grain only is used; and sets of weights are constructed in decimal progression, from 10,000 grains downwards to one hundredth of a grain. By comparing the number of grains in the avoirdupois and troy pound and ounce respectively, it appears that the troy pound is less than the avoirdupois, in the proportion of fourteen to seventeen nearly; but the troy ounce is greater than the avoirdupois, in the proportion of seventy-nine to seventy-two nearly. The *carat*, used for weighing diamonds, is $3\frac{1}{6}$ grains. The term, however, when used to express the fineness of gold, has a relative meaning only. Every mass of alloyed gold is supposed to be divided into twenty-four equal parts: thus the standard for coin is twenty-two carats fine; that is, it consists of twenty-two parts of pure gold, and two parts of alloy. What is called the *new standard*, used for watch-cases, &c., is eighteen carats fine.

3. *Ancient Weights.*—It is well known that this subject is involved in considerable difficulty. The following table gives the estimates of different authors, in regard to some of the ancient weights.

	English Troy Grains.
Attic obolus	= 8·2 Christiani. 9·1 Arbuthnot.
Attic drachma	= 51·9 Chr. 54·6 Arb. 69· Paucton.
Lesser mina	= 3,892 Chr.
Greater mina	= 5,189 Chr. 5,464 Arb. 6,900 Pauc.
Medical mina	= 6,994 Arb.
Talent = 60 minæ	= ½ cwt. English.
	Grains.
Old Greek drachm	= 146·5 Arb.
Old Greek mina	= 6,425 "
Egyptian mina	= 8,326 "
Ptolemaic mina of Cleopatra	= 8,985 "
Alexandrian mina of Dioscorides	= 9,992 "
Roman denarius	= 51·9 = 1-8th Roman oz. Chr. 62·5 = 1-7th Roman oz. Arb.
Denarius of Nero	= 54 Pauc.
Ounce	= 415·1 Chr. 437·2 Arb. 431·2 Pauc.

Pound = 12 Roman ounces.

WEINMANNIA. A genus of ornamental, exotic shrubs of the cunonia family. Two or three species have been introduced to British collections from Australia, one or two from the Cape of Good Hope, and four or five from the tropical parts of America; and several more are known. Most are evergreens of from 4 to 8 feet in height, and carry white flowers in May and June, and love a soil of rich mould; but one or two are deciduous, and one or two red-flowered. Their leaves are variously pinnate, trifoliate, elliptic, and ovate. The bark of one is used in Peru for tanning leather, and is supposed to be employed also in adulterating cinchona.

WELD. See Dyer's Weed.

WELL. A narrow excavation faced round with masonry, for commanding a supply of water. It may either be shallow and open or deep and covered; and may obtain its supplies either by infiltration from the neighbouring surface, or by percolation from comparatively near ponds, streams, or reservoirs, or by ascent from deeply-seated and far-extending strata in the manner of natural springs and Artesian wells; and it therefore may afford water of almost any conceivable quality, from ditchy to limpid, from brackish to sweet, from very soft to very hard, and from saline to chalybeate or sulphureous; and it also may either be copious or stinted, either steady or fitful, and either uniform in the quality of its water all the year round or diversified according to season and weather. See the articles Water, Spring, Artesian Well, and Pump.

A district of drift or diluvial clay is the most favourable for the forming of wells. This substance constitutes the subsoil of a large portion of the champaign or arable parts of Britain; and though the clay or main bulk of it is impervious to water, it is both intersected with small veins of sand and other porous matter through which water percolates, and interspersed with numerous small boulders which lie like plugs upon pervious strata, and whose removal is followed by a permanent oozing or infiltrating or uprising of water. In ordinary conditions of argillaceous diluvium, a well seldom requires to be sunk to a greater depth than from 8 to 16 feet in order to command a copious and constant supply; though when the clay is hard and contains few or no interspersions and intersections of stones and sand, a well of less depth than from 30 to 50 feet may prove wholly useless.

A district of stratified rocks, in most places where they are but thinly or not at all overlaid with diluvium, or where they almost or altogether crop here and there out of the surface, is generally to the full as favourable for wells as a district of drift; for it often yields a good and plentiful supply at a depth of only from 6 to 8 feet; but it not unfrequently has the disadvantage of letting the water as freely out at one side of the well as it lets it in at the other,—so that, in some instances, the side of the well on which the seams of the rock dip downward require to be puddled.

Districts of deep, unctuous, homogeneous clay seldom have water near the surface or within the range of the clay itself, but generally afford it in great abundance, though sometimes of indifferent quality, at such considerable or great depth as reaches to the formations below the clay. The carse lands of Scotland, in general,

are quite impervious to water, but not very deep and nowhere far from rivers or estuaries; and they commonly afford a supply through any excavation which is merely deep enough to reach the level of the bed of the nearest river or estuary, yet can seldom command it of such pleasant quality as is common in drift and sandstone districts. The lands of the London great clay basin are as impervious to water as the carse lands, but greatly or even prodigiously deeper, so that they often need to be pierced to the depth of from 100 to upwards of 560 feet before they can command supplies. The chalk districts of Hampshire, too, are nearly as unfavourable as the worst parts of the London clay basin; for they sometimes will yield little or nothing till bored to the depth of from 300 to 400 feet, though they then yield in great abundance.

Districts of trap rocks, granite, and other amorphous or crystalline rocks, wherever they are bare and homogeneous, or want a deep covering of diluvium or a great intricacy from geognostic disturbance, are eminently unfavourable for wells. The effecting of excavations in them by blasting is very expensive, and may be perfectly useless; yet when they present many cracks and fissures, and are known or well conjectured to overlie a system of stratified rocks at a small or manageable depth, they may sometimes be easily and economically enough pierced, from the bottom of a blasted excavation, with an augur and rod in the manner of an Artesian well.

WENDLANDIA. An ornamental, greenhouse, evergreen, white-flowered, twining plant, of the moonseed family. It was introduced to Britain from Florida about 90 years ago; it constitutes a genus of itself, and is specifically called the poplar-leaved; it attains a height of about 10 or 12 feet, and blooms in June and July; and it thrives in any common soil, and is propagated from cuttings.

WERNERIA. A small, handsome, greenhouse, evergreen herbaceous plant, of the jacobea division of the composite order. It was introduced to Britain about 21 years ago from Quito; it constitutes a genus of itself, and is specifically called the rigid; and it loves a soil of sandy peat, and is propagated by radical division. It was named in honour of the distinguished mineralogist Werner.

WESTRINGIA. A genus of ornamental, Australian, evergreen shrubs, of the labiate order. Nearly a dozen species have been introduced to the greenhouses and conservatories of Britain; and most have a height of about 3 feet, and bloom from May till August,—two or three have pale blue flowers, and the rest have white flowers, —most love a soil of sandy peat,—and all are propagated from cuttings.

WEYMOUTH PINE. See Pine.

WHALE OIL. See the articles Blubber and Oil.

WHEAT,—botanically *Triticum*. A large and very important genus of grasses, of the terminally spiked order. About thirty species, besides a great multitude of varieties, at present belong to it; about as many more which formerly belonged to it, are now assigned to the recently constituted genus agropyrum; and several others which were formerly included in it, more properly belong to the genera secale, schlerochloa, and brachypodium. All the present triticums are hardy exotic annuals,—four of them varying in height from 6 to 24 inches, and possessing very little interest, and the rest varying in height from 2½ to 6 feet, and ranging in value from inferior economical plants cultivable only in their native regions to the richest cereal grasses of all the temperate parts of the civilized world. All or almost all the agropyrums are hardy perennials, and either worthless or mischievous weeds; most have a height of between 6 and 18 inches; four, including the notorious couch-grass with its several varieties, are natives of Britain; and nearly all the rest have been introduced as botanical curiosities, principally from Siberia, Tauria, and Continental Europe.

Ancient Wheat.—Cereal wheat, like cereal barley, was known at a very early age of the world, and figures in remote records of both sacred and civil history, and has been unintermittedly and extensively cultivated, in many parts of the world, from ancient times till the present day. So early as the time of the patriarch Jacob, "the days of the wheat harvest" seem to have been a recognised and signal period of the annual seasons. When the hail-plague fell on Egypt, previous to the exodus of the Israelites, "the wheat and the rye were not smitten, for they were not grown up." The land of Promise, when the Israelites were about to be conducted into it as their inheritance, was described to them as "a good land, a land of brooks of water, of fountains and depths that spring out of valleys and hills, a land of wheat, and barley, and vines, and fig-trees, and pomegranates, a land wherein they should eat bread without scarceness." In the peculiar constitution which was established over them for the joint guidance of their political conduct and their religious behaviour, they were bound to "observe the feast of weeks, of the first-fruits of wheat harvest, and the feast of ingathering at the year's end." When Gideon was summoned by a special call from the Divine Being to go forth as their Judge, and to deliver them from the Midian oppression, he was found "thrashing wheat by the wine-press to hide it from the Midianites." During the long and close league which subsisted between Solomon and the king of Tyre, for the supply of cedars from Lebanon for the building of the temple at Jerusalem, "Solomon gave to Hiram year by year twenty thousand measures of wheat for food to his household, and twenty measures of pure oil." The impartation of great prosperity

and lofty happiness is metaphorically described as a "feeding with the finest of the wheat;" and a vivid declaration of the immeasurable inferiority of human ethics to the word of God, is made in the figurative interrogatory, "What is the chaff to the wheat?" And a number of other statements and allusions occur in the ancient inspired writings, all showing as these do, that, in the very remote times when these writings were penned, wheat had long been a regularly and generally cultivated crop, that it was raised and gathered and thrashed by the heads of families and leaders of the people, and that it was held in high or even paramount esteem as a rich and grateful bread-stuff. Clear monumental evidence exists, too, of wheat having figured from the most remote times as a favourite plant on the banks of the Nile; and grains of it, possessed of vitality, have been found within the cerements of some Thebean mummies. But the wheat of Palestine appears to have been of a much better kind than that of Egypt; and the wheat of some districts of Palestine had the reputation of being better than that of others. It may even be presumed from the passage, "In the sweat of thy face shalt thou eat bread," that a knowledge of wheat was coeval with the first man,—and from several passages in the later books of the sacred scriptures, that material improvements in selecting good varieties of it, in preparing the ground for it, and in managing and storing its crops, were effected at least one thousand years before the Christian era.

The Romans of the time of the Cæsars were well acquainted with the advantages of classifying wheats into widely different varieties, and of severally using these for the soils and seasons to which they were respectively best adapted; and they seem generally to have arranged them into two great groups under the names of triticum and far, and to have divided each of these into several kinds. See the article FAR. "Columella mentions three kinds of triticum. The best he calls robus, which he says excelled the others both in weight and brightness; the second he calls siligo, which he says is deficient in weight; and the third kind, he says, is a spring wheat, of the nature of the siligo, and he adds that it is very useful to the farmer, when, by any accident, he is prevented from sowing in the autumn. The other kinds, he tells us, are not profitable, and are cultivated only by those who value themselves upon having a great variety. Of far, Columella mentions three kinds likewise. The first he calls clusinum, which is of a bright white colour; the second he calls venaculum, of which he says there are two sorts, the one red and the other white; and the third is a spring wheat, which he calls halicastrum, and says that it excels the others in goodness and weight. He adds, that it is necessary to have all these kinds both of triticum and far, as it seldom happens that a farm is so situated, that one kind is proper for every part of it; there being, almost in every farm, both wet and dry lands. Almost all the rustic writers agree in this, that far is most proper for wet clay land, and triticum for dry land. 'In wet red clays,' says Cato, 'sow far; and in dry, clean, and open lands, sow triticum.' 'Therefore,' says Varro, 'skilful husbandmen in their wet lands sow far, rather than triticum.' Columella says, 'that triticum thrives best on dry land, and that far is less hurt by wetness.' Though triticum, in general, is represented as best adapted to dry soils, yet that kind of it called siligo is mentioned as proper enough for wet lands. Columella joins it with far, when he says, 'wet and stiff clays do well enough for siligo and far.' He observes that siligo is the whitest kind of the triticum, but inferior in weight,—that it answers very well in a wet seed time, and is proper for land over which water is in danger of running; and he adds, that it may be got with very little difficulty, as triticum, when sown upon land that lies low and wet, after the fourth crop, is turned into it. Pliny likewise observes that the siligo is proper for wet lands; and he mentions some soils on which it is turned into triticum."

The Botanical Characters of Wheat.—The distinctive characters of the genus triticum, in the old or extensive sense of it, are terminally spiked inflorescence,—two-valved and quite or nearly equal glumes,—alternate, two-rowed, many-flowered spikelets, transverse or so placed that the edges of the florets are towards the rachis,—and two paleæ surrounding the seed, the external or lower one either armed or pointed, and the internal or upper one cleft at the point. The rachis or shaft is jointed; the spaces between the joints are called the internodii; the spikelets, rising one above another on each side of the rachis, constitute the spike, or ear, or head; the glume or lowermost shield of each spikelet corresponds to the calyx of non-gramineous plants, and each of the florets to a corolla; some certain florets in each species, in general, are fertile, while others are barren; and the aggregate inflorescence of the several species differs very widely in the length and form of the rachis, the size and shape and packing of the spike, the comparative length of the glumes, and the number and fertility of the florets, and, above all, in the various properties of the seeds.

The distinctive characters of many of the species are sufficiently obvious and invariable to serve the purposes of the most stringent classification; but those of some others, particularly of such as are very extensively cultivated and as run much into varieties, either shade so greatly off through these varieties, or are so liable to change under the influences of climate and soil and time of sowing as to render the drawing of any precise line of demarcation between different species in some cases exceedingly difficult, and in one or two quite impossible. "Some wheats of an ap-

parently peculiar nature," remarks the author of the Useful Knowledge Society's Treatise on British Husbandry, "have been introduced to Britain from other countries,—as the Egyptian, the Polish, the Siberian, the Zealand, and the Talavera wheats,—and additions are being constantly made to the stock from various parts of the world; but, although differing in the proportions which they contain of nutritive matter, as well as in some particulars connected with their growth, yet they have all sprung from one origin,—and, being composed of similar elements, they are applied to the same purpose. Botanists, indeed, class some of them as distinct species; thus, for instance, the Egyptian wheat produces several ears from the same stem, which is not the case with any other sort; but, when repeatedly sown upon poor land, its supernumerary ears become gradually diminished, and it at length loses all appearance of variety. In like manner, other kinds of wheat, produced in soils and climates more favourable to vegetation than our own, have flourished when first grown in this country, and have appeared to become habituated to our atmosphere, yet in a series of years have degenerated; while other sorts, imported from a more northern climate, or taken from land of an inferior quality, have, on the contrary, been improved. The same circumstance occurs with respect to those species generally distinguished as winter and spring wheat; for although they seem, from their time of growth, to be of a different nature, yet one can be at pleasure transformed into the other by the common means of culture. Thus, if winter wheat be sown in the month of February, or the beginning of March, a portion of it will ripen, though the lateral shoots will be weak, and the crop will only be moderate. If, however, the seed thus produced be sown the next spring, it will throw out stronger stems, will tiller with more luxuriance; and, if the operation be repeated in the following year, it will then be found converted into the nature of summer wheat. If, on the contrary, spring wheat be sown in the month of October, and the next winter prove severe, the crop will perish, or can only be saved if it be completely covered by a heavy fall of snow. Should the weather continue mild, the seed will then, however, produce a tolerable crop, which will ripen earlier than autumn wheat; the seed obtained from it will in the following year take longer to ripen than that of the former season; it will also tiller better, and partake so much more of the nature of the winter species, that, if sown in the month of May, it will not produce a crop. Thus, also, however early the true winter wheat may be sown in autumn, it will not produce stems in the same year; but the real spring wheat will do so if sown any time before midsummer." Similar remarks might be made, with more or less force, respecting other supposed specific characters,—either such comparatively broad ones as those which distinguish the Egyptian wheats from the common cultivated wheats, or such comparatively narrow ones as those which distinguish the winter wheats from the spring wheats. Yet the instabilities and gradations in specific character, even though they were both greater and more numerous than they are, affect mainly the niceties of classification, and address themselves principally to systematic botanists; and they neither prevent mutational characters from being as true indexes of intrinsic constitution and adaptations as fixed ones, nor ought to deter agriculturists from appreciating classifications which, whether serviceable or worthless to the purposes of exact botanical science, may in some way or other be decidedly useful to the purposes of farming economy.

The aggregate properties of the seeds and herbage and habit of wheats and wheat-grasses challenge a ready and useful classification of them into British cereal wheats, or such as may be profitably cultivated for their grain in Britain,—foreign cereal wheats, or such as can be profitably cultivated for their grain in some other countries, but not in Britain,—economical herbage wheat-grasses, or such as may be profitably cultivated for their green forage or for pasture in Britain,—and weedy, noxious, and uninteresting wheat-grasses, or such as cannot be profitably cultivated for any purpose either in Britain or in other countries. Among the first of these classes are all the common winter wheats and spring wheats, the square-eared, the turgid, the stiff, the Egyptian, the Polish, the Bengal, the zea, the spelt, and the one-eared wheats; among the second class are the proud, the Linnæan, Gærtner's, the broad-spiked, the shell-seeded, the two-seeded, the dark-headed, Cevallos's, Cienfuegos's, Bauhin's, the three-seeded, the small-veined, and the villous wheats; among the third class are the dog, the rushy, and the crested wheat-grasses; and among the last class are the notorious couch-grass, the greater part of the agropyrum genus, and the Spanish, Cretan, field, and squarrose wheat-grasses.

The cereal wheats, throughout all their species and varieties, possess a tendency, stronger in some kinds and weaker in others, when sown together either in mixture or in juxtaposition, to form hybrids and to effect an interfusion of characters. Yet, as to the great properties of at once texture of ear and grain, chemical composition of seed, and economical adaptation to different climates and uses, they readily admit of classification into hard wheats, soft wheats, and Polish wheats. "The hard wheats are the produce of warm climates, such as Italy, Sicily, and Barbary; the soft wheats grow in the northern parts of Europe, as in Belgium, England, Denmark, and Sweden; the Polish wheats grow in the country from which they derive their name, and are also hard wheats,—and it is from their external form that they are distinguished from

other wheats. The hard wheats have a compact seed nearly transparent, which, when bitten through, breaks short, and shows a very white flour within. The soft wheats are those usually cultivated in Britain; they have an opaque coat or skin, and which, when first reaped, gives way readily to the pressure of the finger and thumb. These wheats require to be well dried and hardened before they can be conveniently ground into flour. The Polish wheat has a long chaff which is much longer than the seed, a large oblong hard seed, and an ear cylindrical in appearance; it is a delicate spring wheat, and not very productive in the climate of England,—hence it has only been occasionally cultivated by way of experiment. The hard wheats contain much more gluten, a tough viscid substance which is very nutritious, and which, containing a portion of nitrogen, readily promotes that fermentation, or rising, as it is called, of the dough, which is essential to good light bread. The quantity of this varies with the soil and climate, from 5 per cent. in some soft wheats to 30 per cent. in the hardest and most transparent. It is this quantity of gluten which causes the Italian wheats to be used exclusively for the rich pastes which form so large a portion of the food of that nation. The soft wheats contain the greatest quantity of starch, which fits them for the vinous fermentation, by its conversion into sugar and alcohol. For brewing or distilling, therefore, the soft wheats are the best." [Rham's Dictionary of the Farm.]

The cereal wheats, when viewed with reference to the form of their ears or the aggregation of their spikelets, may be classified into the common, the compact, the turgid, the compressed, the nodding, and the meagre. The common have a slightly compressed spike, and are either awned or beardless, white or red, and comprise all the ordinary winter wheats and spring wheats of Britain; the compact have a square beardless spike, and possess in other respects a close affinity to the common wheats; the turgid have a compact bearded spike, generally but not always square, and comprise, among other kinds, the rivet, the Turkey, the St. Helena, and the Egyptian wheats; the compressed have large, broad, bearded, compressed ears, elongated spikelets, and large shining chaff, and comprise the hard wheats of the Mediterranean and of South-Eastern Asia, and the Siberian, Tangier, and hard Sicilian wheats; the nodding have long, loose, bearded, nodding spikes, and comprise the Polish wheats; and the meagre have long, erect, thin spikes, and comprise the zea, the Bengal, and the spelt wheats.

Beardless and bearded, or awnless and awned, are very obvious characters of the cereal wheats, and might seem to afford a ready criterion for arranging them into two great classes, and are apt to be eagerly viewed by most superficial and vulgar observers as far more distinctive features than any which can be found in the florets or the seeds; yet, though they coincide to a certain extent with some of the classifications which have reference to the form of the ear or the aggregation of the spikelets, they do not of themselves possess any real indicational value, either botanical or economical. The beards or awns of almost any grasses, and particularly those of wheats, are so dependent on climate, culture, soil, and other circumstances for size, for persistency, and even for existence that, in many instances, they fail to indicate with permanence or certainty even a subvariety of any species. Some wheat-awns are but a degree longer than a mere point, and others are one, two, or several inches long; some are so laxly seated as to be easily blown away by winds when the grain is ripe, and others are almost as stubbornly persistent as those of the common barleys; some appear with tolerable steadiness in all the species of a genus or group, and others are altered or suppressed or produced in a single variety by a mere change in the circumstances of climate and culture. The only real value of the distinction between beardless and bearded wheats, is that, in the case of the common cultivated British sorts, the beardless ones have commonly larger ears, less remote spikelets, and larger and less elongated grains than the bearded ones; but even this rule is very far from being constant. And as to a prevailing custom of identifying beardless common wheats with winter wheats, and bearded common wheats with spring or summer wheats,—this is much more inconstant than even the rule we have stated, and has sometimes a tendency to lead to serious practical error; for though most of the beardless common wheats, both white and red, are really winter wheats, yet a few are just as really spring wheats, or have not sufficient hardiness for autumnal sowing,—while, on the other hand, some of the bearded common wheats, both white and red, are really winter wheats, or are as hardy and require as long a time to attain maturity as the generality of autumn sown beardless wheats.

The cereal wheats suitable for cultivation in Britain, as well the compact, the turgid, and the compressed kinds, as the common kinds, may, with reference to their comparative hardiness and earliness, be very properly classified into winter wheats and spring wheats; every kind being a winter wheat which is hardy enough for autumnal sowing, or which does not ripen soon enough or bear a sufficient produce when sown in spring,—and every kind being a spring or summer wheat which cannot withstand the rigours of our winter, or which has the power of running so rapidly to maturity that it may be sown in the month of April or in the early part of May,—and every kind, of course, being both a winter wheat and a spring wheat which possesses suitableness alike or nearly alike for autumnal and for vernal sowing. And when, ac-

cording to the current usage of most farmers and seedsmen, winter wheats and spring wheats are restricted in classification to the common eared wheats, they may be understood as generally distinguished from each other also by the winter kinds having both larger grains and more straw than the summer kinds, and yet as so closely akin or specifically identical that they always fuse into each other through their extreme varieties, and may at any time be converted into each other by means of persevering culture. To distribute the common-eared wheats, therefore, into two species under the names of *Triticum hybernum* and *Triticum æstivum*, we regard as wrong, both because it sanctions an improper classification of these wheats themselves, and because it withdraws the distinction of winter and spring from all other wheats; and to group the common-eared wheats into one species, under the name of *Triticum sativum*, as Mr. Lawson does, we regard as both truer to nature and more convenient for practice. A popular name or rather synonyme of the common winter wheats is Lammas wheats.

White wheats and red wheats, downy-chaffed wheats and smooth-chaffed wheats, are subgroups of the common-eared wheats, and particularly of the common winter wheats. The difference in colour arises chiefly from the soil, —many white wheats becoming gradually darker and ultimately red when cultivated on stiff, wet, clay lands, and many red wheats becoming gradually yellow and eventually white when cultivated on rich, light, mellow soils; and the grain undergoes the change of colour more rapidly than the chaff and the straw,—so that, in the case of subvarieties and of specimens which are in the actual course of transition from the one extreme of colour to another, wheats occur with red grain and white chaff or white straw, and wheats also occur with white grain and red chaff or red straw. Yet the colours have very different degrees of constancy in the case of downy-chaffed and smooth-chaffed varieties; and almost all stubborn or permanent reds have far thicker and coarser skins, a much hardier constitution, and a far better adaptation to very stiff and plastic soils than either the mutable reds or the whites. "There are two distinctions," says the author of British Husbandry, "which run through every species of winter or Lammas wheat, and these consist in the colour of the grain, which is either white or red; and there are also two general varieties of these, the grain of which may be classed as the thick and thin husked, or the downy-chaffed and the smooth-chaffed. The red wheat, or thick-skinned quality, is usually grown upon the strongest clay land, and degenerates slightly when sown upon soils of a lighter description. It is of various shades of a reddish brown, or deep-yellow tinge, and generally retains the same hue, whatever may be the quality of the ground on which it is produced. The outer husk is coarse in proportion to the humidity of the soil, and consequently lowers the value of the grain; which, accordingly, bears a price in the market of from 12 to 15 and sometimes 20 per cent. less than fine qualities of the white. It is, however, so hardy, and so much better adapted to ensure the production of a crop on wet and adhesive soils, that it is very generally sown on land of that description. On fine loams, or soils of that kind which are usually considered as good barley-land, the white or smooth-chaffed wheat is, however, preferred, from the thinness of the husk rendering it more profitable to the miller. The downy-chaffed variety was formerly in the greatest repute; both from its generally producing the whitest and the finest flour, and from the grain in consequence of the shortness of the straw, and the closeness of the ear, being less liable to be shaken out by the wind at harvest-time, than the smooth-chaffed tribes,—qualities which peculiarly adapt it to land of so rich a nature as to endanger the lodging of the crop. In consequence, however, as it is supposed, of the husk retaining the dew and moisture longer than the other sort, it was found more liable to be affected by mildew, and to be in other respects so much more tender, that it has fallen much into disuse; and the thin-chaffed wheats are now more generally cultivated, particularly throughout Scotland."

We shall only notice further the classification of the common-eared wheats made by Mr. Lawson, under his species of *Triticum sativum*. The first are varieties generally termed white beardless wheats, having whitish coloured ears or spikes, and light coloured grain or seed; and which are generally cultivated as winter wheats. Those enumerated are common white wheat, Hunter's wheat, Mungoswells wheat, Uxbridge wheat, Chiddam wheat, white Essex wheat, Jeffray wheat, Gregorian wheat, white golden drop, Talavera wheat, white Dantzic wheat, red Dantzic wheat, white velvet or woolly-eared wheat, white Hungarian wheat, white Flanders wheat, white Naples wheat, white Touzelle wheat, and white beardless Odessa wheat.—The second are varieties generally termed red beardless winter wheats, from the reddish colour of their spikes or ears, and their being more particularly adapted for winter sowing. Those enumerated are common or old red wheat, blood red wheat, golden or red Essex wheat, red Kent wheat, Lammas or red English wheat, red golden-drop wheat, purple stalked golden-drop, white stalked mouse-tail red wheat, red-stalked mouse-tail wheat, sulphur-coloured wheat, red beardless Caucasian wheat, velvet or woolly-eared red beardless wheat, red velvet or woolly-eared wheat of Crete, and Hickling's red wheat.—The third are white wheats, more particularly adapted for spring sowing; but which, from having no awns or beards, or at least very short ones, belong to the group generally termed winter wheats. Those enu-

merated are Leghorn or Tuscany wheat, white beardless Tuscany wheat, common white beardless spring wheat, white spring wheat of Fellemberg, and hard spring wheat.—The fourth are red beardless wheats, which are more particularly adapted for spring sowing, but generally not included under the specific name of spring wheats in consequence of their having almost no awns. Those enumerated are red beardless Tuscany wheat, and common red beardless wheat of France.—The fifth are white bearded wheats, generally termed summer wheats, but really as hardy and requiring as long to arrive at maturity as the generality of the beardless winter wheats. Those enumerated are the common winter bearded wheat, white bearded Shanry wheat, light yellow-bearded winter wheat, woolly-eared white bearded wheat, white bearded Tuscany wheat, Chinese bearded spring wheat, Victoria wheat, common bearded spring wheat of the French, Tuscany wheat, Cape wheat, and small Sicilian bearded spring wheat; and the seven last of these, from the white bearded Tuscany wheat and onwards, are particularly adapted for spring sowing.—The seventh are red, awned, or bearded wheats, generally denominated summer wheats, but really as hardy and requiring as long to arrive at maturity as the generality of the beardless winter wheats. Those enumerated are velvet or woolly-eared red bearded wheat, fern wheat, red-bearded Mendoza wheat, and red Chinese wheat; and the three last of these are particularly adapted for spring sowing.—All these varieties, and also a number of others, will afterwards be described.

The Wheat-Grasses.—None of the foreign weedy or uninteresting non-cereal wheats require to be described; the principal British one—the most mischievous by far of all grassy weeds—is described in the article Couch-Grass; and the other indigenous species are the only non-cereal wheats which possess any pretension in this country to a cultivable character or economical adaptation, and will form the proper subject of the present short section.

The rushy or sea-rushy wheat-grass, *Agropyrum junceum*, called by Linnæus *Triticum junceum*, is a somewhat abundant inhabitant of the sandy sea-shores of England. Its root is perennial, and comprises numerous woody fibres, and is widely and profusely creeping; its herbage is glaucous and rigid, and looks as if in thorough keeping with its sandy habitat; its stem is simple, inclining, smooth, polished, of a bright violet tinge below, striated above, and from 12 to 24 inches high; its leaves are involute and sharp-pointed; and its flowers bloom in June and July. This plant serves in the same way as the *Arundo arenaria* and the *Elymus arenarius*, for binding the loose sands of the seacoast, and preventing them from drifting inland and desolating the country.

The dry or bearded or fibrous-rooted wheat-grass, *Agropyrum caninum*, called by the old botanists *Triticum caninum*, inhabits woods, lanes, and the shade of hedges, on calcareous soils, in both England and Scotland. Its root is perennial, and differs from that of couch-grass in the essential character of being fibrous and without a rhizome; its stems are very smooth and about two feet high, yet do not give the herbage an average height of more than six or eight inches; its leaves are nearly upright, lanceolate, taper-pointed, flat, thin, rough on both surfaces, and of a bright green colour; and its spikes are awned, bloom in July and August, and generally bear a considerable quantity of seeds. This plant is readily and rapidly raised from seeds on every kind of dry or porous soil, and produces a large quantity of early spring herbage, and might therefore be advantageously cultivated on poor lands in some situations as a substitute for spring-feeding rye-grass; but it yields a very inconsiderable aftermath, and is seriously objectionable on account of its awns, and does not by any means possess a sufficient aggregate of good qualities to warrant the sowing of it upon any kind of prime or even middle-rate land.

The crested wheat-grass. *Agropyrum cristatum*, called by the old botanists *Triticum cristatum*, inhabits dry upland hedges and similar situations, in various parts of Britain, particularly in Scotland. Its roots comprise several long, strong, woolly fibres, and possess special adaptation to a sandy soil; its stems are ascending, simple, rigid, slender, leafy throughout, hairy at the top, and from 10 to 20 inches high; and its ears bloom in July, and mature their seeds in August. This plant yields better early spring herbage than most of the alpine grasses, and produces an abundant and very nutritious aftermath; and it well deserves cultivation, as a pasture-grass on light heath soils.

The loliaceous wheat-grass, or dwarf sea wheat-grass, *Brachypodium loliaceum*, called by the old botanists *Triticum loliaceum*, inhabits the sandy sea-coasts of both England and Scotland. Its root is annual, and comprises many long fibres; its stem is rigid, wiry, leafy, very smooth, polished, either erect or decumbent, very various in luxuriance, and from 2 to 15 inches high; its leaves are linear, acute, and almost smooth, and become involute when dry; and its ears develope and bloom in June and July. This grass is of some use in its native sandy habitats, but does not recommend itself for cultivation.

The Common-Eared Cereal Wheats.—We comprise, under the name of common-eared cereal wheats, all the varieties of what are usually called winter wheats and spring wheats, or common beardless and common bearded wheats, constituting the *Triticum hybernum* and *Triticum æstivum* of botanists; and in grouping and describing the chief, we shall follow the arrangement of Mr. Lawson, noticed in a former section, and shall also avail ourselves in some degree of his descrip-

tions,—adding, however, a great deal of important information from entirely different sources.

Common white wheat is the beardless winter wheat, with whitish spikes and light-coloured grain, cultivated in any district where one or more of the superior or very distinct varieties of winter wheat have not yet come into general use. It does not constitute any one distinct variety, but rather comprises an almost countless number of varieties and subvarieties of white wheats, not even excluding the velvet-eared and some of the bearded sorts. The common white wheats of East Lothian and the Carse of Gowrie, according to specimens preserved in the Highland Society's Museum at Edinburgh, weigh 63 lb. per bushel; the common white wheat of Morayshire, according to a specimen preserved in the same place, weighs 62½ lb. per bushel; and a common white wheat of Scotland, called in general terms 'Scotch white,' yielded, in a well-conducted comparative experiment reported in the Royal Agricultural Society's Journal, 24 cwt. 62 lb. per acre.

Hunter's wheat was first discovered by the late Mr. Hunter of Tynefield, East-Lothian, growing on a field in Coldingham Moor, Berwickshire; and during the last 40 or 45 years, it has been very extensively cultivated, and held in very high esteem, throughout a large portion of the south-east of Scotland. Its ear is medium-sized, thick, tapering a little toward the point, and slightly pendant to one side; and its grain is rather large, elongated, tapering very slightly towards the extremity, plump, and of an uniform dull white or very light brownish colour throughout. Specimens of this variety have been found to weigh from 63½ to 65½ pounds per bushel, and to yield 5¾ quarters per acre. A Hunter's wheat is reported on in some recent English comparative experiments; but it must either be a totally different wheat from the Scotch Hunter's, or have been obtained from very deteriorated sources of seed; for, in these experiments, it gave exceedingly unsatisfactory results.

Mungoswells wheat is the produce of a few ears presenting a superior appearance, which Mr. Patrick Shirreff, Mungoswells, East-Lothian, discovered in a field about 20 years ago. It is generally accounted a few days earlier, and tillers more freely in spring, than Hunter's wheat; and it is also said by some cultivators of it, but denied by others, to be more prolific. In sample, it so very much resembles Hunter's, that the two have often been mistaken for each other by dealers.

The Uxbridge wheat originated in the neighbourhood of Uxbridge in Middlesex. Its ear is large, very compact, tapering very little towards the point, and pendant a good deal to one side; and its grain is rather small, short, plump, and of a very white colour, and forms a beautiful sample, and is preferred by the London millers to the grain of any other variety. "From the trials which have been made of the Uxbridge wheat in this country," says Mr. Lawson, "it appears to be perfectly suited to our climate, very prolific, and deserving of attention from cultivators. It may be considered two or three days later in ripening than the Mungoswells wheat."

Chiddam or Chidham wheat originated in the south of England, and was introduced about 15 years ago to Scotland. It is a prolific variety, and a free grower, and tillers freely in spring. Its grain is slightly more elongated than that of Uxbridge wheat, rather thinner in skin, and more transparent or flinty like; and its flour forms a lighter bread, but darker coloured and more open than that of some of the other most esteemed white wheats. The Chiddam wheat is well-known and much appreciated in some of the best agricultural districts of England, and has been a favourite subject in some recent comparative experiments; yet, notwithstanding its admitted excellence and prolificity, it has been pronounced by some good judges very little or not at all superior to the common white wheats of the districts in which it is best known. Its average yield is probably about 65¼ pounds per bushel.

White Essex wheat resembles the Uxbridge wheat in its ears, and Hunter's or Mungoswells in the size and shape of its grains; but differs from them in being of a whiter colour, more transparent, and thinner skinned. It yields about 65 pounds per bushel; and is much esteemed by the English millers. It ripens about four days later than Hunter's wheat. Its straw is considerably longer than that of any of the varieties hitherto mentioned.

Jeffray wheat is shorter in straw than Hunter's wheat, and five or six days longer in arriving at maturity; and its ear and grain are smaller, and taper more toward the point.

Gregorian wheat is hardy, and tillers well in spring, and is deservedly esteemed. Its straw is more stiff and upright than that of Hunter's or Mungoswells wheats; its ear is longer and less bent to a side; its spikelets are more remote; and its grains are shorter, rather lighter in colour, and more transparent.

The white golden drop wheat differs from most of the common eared wheats, and resembles the turgid wheats in the circumstance of having generally four grains on each spikelet; but it resembles most common eared wheats, and differs from the turgid wheats, in the aggregate of its other characters. Its appearance, whether as a plant or as a grain, is neither coarse nor strong; its straw is rather above the average length; its ears are a good deal pendant; its awns scarcely constitute a beard, and appear only toward the point of the spike, and are seldom longer than the florets; its chaff has a dull white or very light brown colour; and its grain is large sized, of a light brownish yellow or copper colour, and of medium quality. This variety was discovered

by Mr. A. Gorrie, in 1834, in a field of common white wheat.

The Talavera wheat was introduced to Britain about 35 years ago from Spain. Its straw is about average length; its ears are long, thin, and upright, and taper to the extremity; and its grains are very large, and of a whitish semitransparent colour. It ripens about a week earlier than any of the common winter wheats; but, in most of many trials throughout the Scottish Lowlands, and even in some favourably circumstanced trials in England, it has been found so impatient of vernal frost or so deficient in vernal tillering, as not to seem at all suitable for autumnal sowing. It has also been much mixed and confounded with other varieties, and considerably graduated into subvarieties of its own; insomuch that, even about 14 years ago, a genuine unmixed sample of it could scarcely be procured; and a kind of it called the Bellevue Talavera has, since about that time, been the best known and most esteemed in England.

The Bellevue Talavera, soon after its introduction, was tested comparatively with three other prime varieties by Colonel Le Couteur, one of the best British authorities on the culture of wheat, and was spoken of by him in the following terms in 1840:—"This admirable variety is invaluable where it is adapted to the soil and climate. The seed being large, a greater quantity of it should be allowed than usual. This wheat has succeeded in the north of Scotland, and is sufficiently hardy to withstand the winter in its grassy state; but it is otherwise more valuable as a spring crop; without doubt it may be sown as late as the first week in February, in all the milder parts of England, with a prospect of reaping quite as good an average crop from it as from any other wheat, but with a certainty of obtaining more flour than from most. There is no tendency to degenerate observable in this wheat, as far as the experience of five or six years goes; nor, from its early habits, is it at all likely to become intermixed by fecundation from other varieties, though sown about the same period, as it will, in such cases, flower a fortnight or three weeks before them. It is not more liable to disease than ordinary white wheats, and affords a very fine clear white straw; it is indeed one of the Italian bonnet-making varieties. There is, however, one disadvantage in it, which is, that the ear is so heavy that it is apt to break down, though not break off, when swept by a gale about the period of ripening; but it has a countervailing good quality of ripening the grain equally well though bent down, as is the case with spring wheats, which ripen their seed well though quite laid, which with winter wheats is doubtful. Another peculiarity is the tenacity of the chaff to the ear, more remaining on it after passing through the thrashing-machine than any other variety I am acquainted with."

The white Dantzic wheat was introduced to Britain from the countries on the south side of the Baltic; but, though a beautiful and prolific wheat as grown in these countries, it loses very much of both its beauty and its prolificity when grown in Britain, and at the same time is later than most of our ordinary winter wheats in coming to maturity. Its straw is of medium length; its ear is long, tapering, small, and thinly set; and its grain is elongated, very small, and of a beautiful white colour. But in a recent comparative experiment on well-drained clay soil, in favourable circumstances in England, it produced abundant straw and a coarse and indifferent sample of grain, and was greatly less prolific in grain than the other varieties with which it was tried, particularly the Bellevue Talavera, which yielded 36 bushels per acre, while the white Dantzic yielded only 26.

The red Dantzic wheat, also, was introduced from the countries on the south side of the Baltic; and, in spite of its distinctive name, it is far more a white wheat than a red one; and, with the exception of a slightly darker shade of colour in the grain and of a light reddish-brown colour in the ear, it bears a marked resemblance to the white Dantzic, at once in botanical characters, in economical adaptations, in period of ripening, and in comparative habits in its native regions and in Britain. Two samples of mixed Dantzic wheat in the Museum of the Highland Society at Edinburgh weigh at the rate of respectively 61½ lb. and 62½ lb. per bushel.

The Jersey Dantzic is an excellent variety, but appears to be misnamed. "The seed of it," says Colonel Le Couteur, "is described as having been raised from a single ear, originating from seed procured from Dantzic, selected from the finest high mixed. It is, however, suspected to be identical with some excellent sorts, called in Sussex, Kent, and some parts of Surrey, the Chittums; in other parts, Pegglesham; in Berkshire, Trump; in Essex, Hardcastle; in some counties, Old Suffolk; in Scotland, Hunter's White; and assuming several other names. This wheat is not quite so hardy as the hoary white or velvet eared; it is, nevertheless, considered sufficiently so to succeed throughout the kingdom, excepting the northern parts of Scotland. In rich soils, it tillers amazingly, and produces a longer straw than the hoary; nor is it so liable to sprout in a moist climate from being smooth-chaffed. In very severe, moist, and stormy weather, it will be laid sooner than the hoary. It ripens a week earlier at least than the hoary, and should be reaped while the grain can be marked by pressure from the thumb-nail, as it is rather liable to shed if over ripe. In a dry season this wheat will afford a beautiful, clean, white straw, fit for bonnet-making or any purpose of thatching; it is firm and tenacious. In wet seasons, it is rather subject to rust."

The white velvet, hoary white, woolly-eared, downy Kent, stuffed, or hedge wheat, has long

been known and much esteemed in the south of England, particularly in Kent and Sussex, and was introduced thence to France and Scotland. Its straw is short; its ears are small, close, and compact; its chaff has a white colour, and is covered with a fine velvety down; and its grains are middle-sized, well formed, and of a semi-transparent whitish colour. "This wheat," says Colonel Le Couteur, "will withstand the most severe weather. The season 1837 to 1838 was a very trying one both as to wetness and severity of cold, the thermometer having fallen to 18° below freezing; but the crops of this wheat raised by my neighbours were perfectly insensible to it, and of great produce. This wheat is not remarkable for its early maturity, though it cannot be called a tardy variety. It is not subject to degenerate, and if attention is paid to sowing the seed pure, and annually, or even occasionally, varying the manure intended for it, it is possible that it may never degenerate. The only objection to it is the huskiness or velvety ear, which in damp weather is retentive of moisture; and in snatchy seasons the grain is more apt to sprout than the smooth-chaffed varieties. It is not much affected with dust-brand; and when pickled and limed, has never been found with smut-balls. It is little liable to shed, even when over-ripe, and will resist very heavy gales without being laid or broken." This wheat is now cultivated pretty extensively in France; but has not been found at all suitable to the comparatively humid climate of Scotland.

The white Hungarian wheat was introduced from England to France and from France to Scotland; and it is extensively cultivated in the Orleanois and in some of the northern districts of France under the name of English wheat. It has a nearer resemblance to the Chiddam and the Uxbridge wheats than to any other which we have yet described; and it is 6 or 7 days longer in arriving at maturity than most of the common winter wheats. Its ear is white, of medium length, very compact, and square-like, and terminates abruptly or without tapering; each of its spikelets contains four grains; its chaff is smooth and thin; and its grains are small, short, rounded, white, and slightly transparent, and constitute a remarkably beautiful sample, and weigh at the rate of 66 lbs. per bushel.

White Flanders wheat is held in great esteem in the northern parts of France. It appears to differ little from the white Essex wheat, and possibly may have been derived from that variety, and perhaps owes all its difference from it to the effects of climate and cultivation.

White Naples wheat is much cultivated in the southern parts of France; and was introduced a considerable time ago to the neighbourhood of Paris, but was found to be not hardy enough for that climate; so that, in British cultivation, it can rank only as a spring wheat,—though it is perhaps too late in ripening, and too subject to induration from the influence of our climate to take even that rank. Its ear is long and not very compact; its terminal spikelets have awns of from a quarter of an inch to one inch in length; its chaff is delicately tinged with a dull yellow or copper colour; and its grains are large, considerably elongated, and of a yellowish white colour, and weigh well in sample.

The white Touzelle wheat also is cultivated in the south of France, and has been found too tender to endure the winters in the latitude of Paris. Its ear is rather more compact than that of the white Naples wheat; its chaff is of the same colour, but so exceedingly thin and brittle as to allow the fully ripe grains to be readily shaken out by even a light wind; and its grains, when grown in the neighbourhood of Paris, have a brownish-yellow colour, but, when grown in the south of France, are much whiter.

The white beardless Odessa wheat is the best and the only meritorious of a considerable number of varieties of wheat which have been introduced at various times from Odessa into France. It is extensively cultivated in Auvergne, but is more sensibly affected by cold than the common wheats of that province; and it has been found as suitable in France for spring sowing as for winter sowing; but, as tried in a comparative experiment in the vicinity of Edinburgh, it was nearly a fortnight later in arriving at maturity than the common winter wheats of Scotland. Its ear is rather loose and irregular, and has a colour inclining to light brown; and its grains are long, above average size, and whitish coloured, and taper slightly towards the point.

The Hopetoun wheat or Shirreff's Hopetoun wheat originated in an ear of wheat culled in 1832 from a field on the farm of Drew in East-Lothian; and was brought into cultivation by Mr. Patrick Shirreff, and sold for the first time in 1839. "After numerous trials in East-Lothian for two seasons," said Mr. Shirreff in 1841, "this variety is rising in public esteem, and has been successfully grown in many parts of Scotland, as well as in Gloucestershire, Kent, and Buckinghamshire. Everywhere this variety has put forth ears of large size, supported on tall and strong straw, and yielded grain of fine quality; and in England it is represented to have been much less affected this season with red gum, blight, and mildew, than other varieties growing contiguous. Last year a comparative trial was made by Mr. George Bell on the farm of Inchmichael, Perthshire, with Chevalier and Hopetoun wheats, the crop of the latter being represented as too thickly planted. Both kinds yielded 36 bushels per acre; but the grain of Hopetoun wheat was best in quality, and weighed 2 lbs. per bushel heavier. Another comparative trial was instituted in East-Lothian by Mr. Alexander Begbie, on the farm of Seggarsdean, with Hunter, Chidham, and Hopetoun wheat, the latter being thinnest in plant, and the

yield was found to be 34, 30, and 37 bushels respectively." The Hopetoun wheat has been a favourite subject in recent comparative experiments in England; yet, though found superior to most of the older common varieties, has been excelled in various respects by several new kinds.

Whittington's white wheat is very hardy, and, when sown early in autumn, affords much herbage, very fit for being eaten down by sheep in the spring; but it is rather a late wheat, ripening a week or ten days later than the Jersey Dantzic. Its straw is abundant; and its grain is large, full, plump, rather of a whitish-red tint, and a little thick-skinned, and weighs about 62 lb. per bushel. This has been somewhat a favourite variety in recent comparative experiments; but it has pretty generally disappointed expectation, and is apt to blight in certain situations, and is not liked by millers.

Brown's ten-rowed Chevalier or ten-rowed prolific wheat, is an admirable variety on soils and situations congenial to it, but is somewhat nice as to climate, and succeeds but poorly on some lands where other wheats prosper. Its straw is long and abundant; and its grain affords a beautiful sample.

The Russell white wheat has moderately short straw, and a compact head; and, though by no means a new variety, is decidedly superior to many newer kinds which have obtained a greater notoriety; but is too delicate in habit to suit any but the most favourable soils. An interesting and most singular subvariety of it was selected in 1833 by Mr. Rivers of Sawbridgeworth, "This," says Mr. Rivers, "combined with an extraordinary stiff straw a singular clustered ear, forming a cluster at the top of densely set grains, making a perfect five set, constituting 110 entire grains in the one ear, more resembling an artificial figure carved in ivory than a natural product. I have been much gratified since in experiencing its permanency, having the most beautiful appearance in the field, growing about 4 feet 6 inches high, with a very stiff straw, and the most violent winds and rains cannot lodge or lay it."

Other varieties of beardless white wheat, which have more or less commanded the attention of British agriculturists,—some possessing a high degree of reputation, most of quite or comparatively recent origin, and nearly all of the class of winter wheats, — are Hillyard's snowdrop, Jonas's prolific, the silver drop, the golden swan, the Taunton, Smither's Hereford, Sewell's, Hickley's prolific, Baxter's, Brodie's, the Carrington, the Cheltham, Courtney's six-rowed yellow or six-rowed Chevalier, the Chinese small, the dwarf cluster, the tall cluster, Colonel Le Couteur's compact, Colonel Le Couteur's round, Colonel Le Couteur's early Cape, the Duke William, the eclipse, the Eltham, the Heartswood, Hickling's yellow, Incledon's prolific yellow, the Indian, the Kentish, King William yellow, the Malaga, the Oxford prize, the painted-stalked, the Paris, the pearl, the salmon-coloured, the Lark yellow, the Saumur yellow, the striped chaffed early yellow, Vilmorin's, and Whitworth's prolific.

The old or common red wheat has been almost wholly superseded in Britain by some of the newer and more prolific varieties of red beardless winter wheat; but it is still cultivated to a considerable extent, under the name of *froment rouge ordinaire sans barbes* or common beardless red wheat, on tenacious soils or very strong clays in the north of France. Its ear is medium-sized, and almost upright; its spikelets are not very closely set; and its grains are elongated, and of a dull reddish colour.

The blood-red wheat is very prolific, and has for a good many years past been more extensively in favour thoughout large districts in Britain than any other kind of red winter wheat. Its straw is long and rather stout, and is not apt to become lodged; its ears are large and of rather a bright brownish-red colour, and taper very slightly to the point; its spikelets are close and spreading; and its grains are medium-sized, slightly triangular or cornered on the sides, and of a dark yellowish or copper colour, but are most yellowish or copperish at the thickest end, and are generally darker and more transparent at the other end. This wheat is usually less esteemed than any of the ordinary white winter wheats, and is often estimated by millers and bakers at two or three shillings per quarter less than any of these; and yet a mixture of it with a white sort, in the proportion of a fourth or so of the red, is frequently preferred to a pure or unmixed white,—and such a mixture is made by many English farmers in sowing the crop, and is thought by them to be specially economical, some seasons, as they reckon, being most favourable to the red, and others most favourable to the white, so that every season or any one acts averagely on the mixture.

The golden wheat or red Essex wheat is also a very hardy, prolific, and much esteemed variety. It bears considerable resemblance to the blood red wheat; but its ears are longer and less compact, and taper more toward the point,—and its grains are longer, not so round and plump, and more obtusely angled on the sides.

The Kent red wheat is well known and much esteemed in the south of England, and has been a favourite subject in some recent comparative experiments. Its ear resembles that of the golden wheat; but its grains are much larger, of a darker and more uniform colour, more transparent, and comparatively hard and flinty,—and they weigh at the rate of about 64 lb. per bushel.

The old red Lammas wheat, or red English wheat, bears a marked resemblance in general character to the Kent red wheat, and probably is a mere duplicate of that variety modified by climate, soil, and culture. It was long ago in-

troduced from England to the north of France, and has been cultivated there with considerable success; yet, in consequence probably of the winter being generally colder there than in the south of England, it is found less resistive of the frosts in the neighbourhood of Paris than the common red wheat. The French consider it as yielding a finer sample than any other of the red wheats. It is liable to be shaken when fully ripe, and should, therefore, be cut a day or two before arriving at full maturity. Its ears are more waved than those of the red Kent wheat, thinner, and not so much reclined to the side; and its spikelets have a bright red colour toward the extremity, but are lighter and more copperish toward their base.

The red golden-drop wheat is similar to the blood-red wheat, in at once general character, agricultural adaptation, and economical value. Its straw is shorter; its ear is similar; and its grain is about the same size, lighter and more uniform in colour, and more elongated and rounded on the edges. It also requires a few days longer to arrive at maturity.

The purple-stalked golden-drop wheat was picked up in a field of common wheat, in 1834, by Mr. Gorrie of Annat Garden. It resembles the red golden-drop wheat; but its ear is darker-coloured and more compact, its grain is rather brighter in colour, and its straw, especially a few days before ripening, has a dark purple tint. It is a good variety.

The white-stalked mouse-tail red wheat, and the red-stalked mouse-tail red wheat, were also picked up in a field of common wheat by Mr. Gorrie of Annat Garden; but they are comparatively unprolific or of inferior quality. The ear of the former is long, thin, tapering, and pointed; and the grain is elongated, and of a brownish-yellow colour, irregularly interspersed with dark semi-transparent spots or blotches. The ears and the grain of the red-stalked are darker-coloured than those of the white-stalked; and the straw has a purple colour.

The sulphur-coloured wheat is rather a good variety. Its ear is somewhat more compact than that of the two mouse-tail kinds, and its grain is shorter, plumper, and of a yellow sulphury colour.

The beardless red Caucasian wheat is one of the earliest red winter wheats, and is sometimes sown in France as a spring wheat; but it is of poor quality, and not much deserving the British farmer's attention. Its ear is long, upright, and of a dull-red colour; its spikelets are remote, large, and spreading; its chaff is thick and hard; and its grain is elongated, semi-transparent, rather above the medium size, hard and flinty.

The red velvet-eared or red woolly-eared beardless wheat is of medium productiveness; but, like the white velvet-eared wheat, it is little esteemed in consequence of its woolly ears being apt to retain moisture in damp weather, and to become discoloured and liable to sprout. Its ear is short and compact; and its grain is slightly elongated, of a dark red colour, and flinty.

The red velvet-eared or red woolly-eared wheat of Crete is of a somewhat superior quality. Its ear is compact, downy, and of a deep red colour; its spikelets are large and spreading, and contain each four and often five grains; and its grains are short, slightly angular, and of a reddish opaque yellow colour.

Hickling's red wheat, or Hickling's prolific red, is a productive but rather coarse variety. Its straw is long, stout at the base, and tapering at the top; its ear is short, thick, close, and heavy; its chaff is white; and its grains occur four in the row across the ear, and have a dark orange-red colour, and are short, plump, and thin-skinned.

Smoothey's or Boishall red wheat was discovered by Mr. Thomas Smoothey, Boishall, near Halsted, Essex. The straw is fine; the ears are short, thick, and closely set; and the produce of the grain has been rated as high as seven quarters per bushel.

The Waterloo red wheat was first raised at Midham, in Suffolk. The straw is long, strong, and stiff; the ears also are long, strong, and stiff; and the grains are longish, round, thin-skinned, and of a light orange-red colour.

Other varieties of beardless red or brown wheat, which have more or less commanded the attention of British agriculturists,—some possessing a high degree of reputation, most of quite or comparatively recent origin, and nearly all of the class of winter wheats,—are the marigold or Rattling Jack red, the thickset Suffolk, Hobbs's brown or Essex brown, the Burwell brown, the Britannia red, the red Champion, Hobbs's red marigold, Spalding's red or Spalding's prolific red, the Colne white chaff, the Bristol, Sharp's or Goody's or Crabb's, Seyer's, Sewell's, Piper's thickset, the branching red, the Cambridge brown, the Cape early red, Clover's red, the creeping red, the Dantzic common red, the Flanders long-eared red, the La Manche red, the Marianopoli red, the Touzelle red, and the Waterloo red.

The Leghorn or Tuscany wheat is cultivated in the south of Europe for the purpose of making straw-plait for bonnets; and was introduced to Britain with the view of being used here in the same way, but has been entirely superseded by the common rye. "The name of Leghorn or Tuscany wheat, however," says Mr. Lawson, "appears not to apply to any one particular variety, but rather to a mixture of white, red, bearded, and beardless sorts. The white beardless varieties seem, however, to be the most numerous. The whole seem to belong to the early or spring sorts, which is no doubt caused by their being sown in their native country always in March, on light sharp sandy soils on the banks of the Arno. When intended for plait, the seed is

sown very thick and the plants pulled when in flower, or before the grain is formed, when they are generally about eighteen inches in height. It is then bleached and tied up in the same manner as we do flax, previous to selecting the portion of the stalk to be used in the manufacture, which is that between the ear and the first knot or joint of the straw."

The white beardless Tuscany wheat was picked out about 20 years ago from a field of Leghorn wheat by Mr. A. Gorrie, and has been cultivated as a spring-sown grain wheat. Its ear is long; its spikelets are not very closely set; and its grains are light-coloured, clear, transparent, and thin-skinned, and weigh at the rate of about 63 lbs. per bushel. This wheat is very productive.

The common white beardless spring wheat is cultivated as a spring wheat in the central districts of France to as great an extent as any of the winter sorts; but, as introduced or imported into Britain, it generally is much mixed with the common white bearded spring wheat of France. Its ear is long, small, and tapering; its spikelets are remote; and its grain is short, plump, and of a dull yellow or brownish colour.

The Fellemberg white spring wheat, or white spring wheat of Fellemberg, is also a French spring wheat, and seems to be a very vigorous grower; but, in consequence of its seeds being small and very hard and exceedingly liable to be shaken out when ripe, it is not much cultivated. Its ear is very white; its spikelets are broader and more closely placed than those of the common white beardless spring wheat; and its grains are small, slightly elongated, of a clear transparent reddish colour, and very hard or flinty.

The hard spring wheat is likewise a French spring sort; and is regarded by the French as merely a subvariety of the Fellemberg wheat; and was originally obtained by them from the same district as that wheat. But its chaff is stronger, and its grains are less flinty and not so liable to be shaken out. Even this wheat, however, is not much cultivated.

The red beardless Tuscany wheat ripens almost as early when sown in March as if sown in Autumn. Its ear is large, rather compact, and of a darkish red or brown colour, and bends to one side, and presents a considerable resemblance to that of the blood-red wheat; and its grains are larger, more pointed, and of a more uniform yellowish brown colour than those of that variety. If sown at the same time as the blood-red wheat, it ripens 8 or 10 days earlier.

The common red beardless wheat of France is rather a poor variety, and has not been much cultivated by the French. It was originally introduced to France from the north of Germany. Its ear has a pale red colour; its spikelets are closely set; and its grain is reddish, of medium size, and rather hard or flinty.

The common winter bearded wheat is a comparatively worthless variety, and has gone almost entirely out of cultivation, but may be frequently seen mixed in small quantities with common white winter wheat. Its ear is thin, short, and tapering to the point; its awns are considerably longer than the ear; and its grains are small, elongated, of a light reddish colour, and rather hard or flinty.

The white bearded Shanry wheat was picked out of a field on the farm of Shanry by Mr. A. Gorrie, and is a very superior variety of bearded winter wheat. Its ear is longer and more compact than that of the common winter bearded wheat; its awns are much shorter; and its grains are larger, softer, and of a light yellowish colour.

The light yellow bearded winter wheat is hardy and productive, and was at one time very much cultivated in France; and though now extensively superseded by the white beardless varieties, it is still a good deal cultivated in several large districts, and is much esteemed by both millers and bakers. Its ear is compressed; its awns are long and spreading; and its grains are medium-sized and of a reddish yellow colour.

The woolly-eared white bearded wheat was picked up by Mr. A. Gorrie along with the Shanry wheat; and it differs from that variety simply by having its ears covered with fine wool or down. "There are doubtless," remarks Mr. Lawson, "many sub-varieties of this as well as of the other downy or woolly wheats, possessing various degrees of merit; but as cultivators seem to have a prejudice against woolly wheats in general, the varieties are hitherto little known."

The white bearded Tuscany wheat was originally selected by Mr. A. Gorrie from a quantity of Leghorn wheat, and has been cultivated as a spring-sowing grain wheat, and yields a sample of very superior quality. Its ear differs little from that of the white bearded Shanry wheat, except in having rather longer awns; and its grain is longer, plumper, and of a very light colour,—and comes sooner to maturity, and is better adapted for spring sowing.

The Chinese bearded spring wheat was introduced to Britain from Germany by the late Mr. Loudon, and reintroduced from Russia by Mr. Lawson; and it showed, at its introduction, an extraordinary and almost destructive liability to rust. Its ear is nearly similar to that of the white bearded Tuscany wheat; and its grain is white, slightly transparent, a little elongated, and well filled, and forms an excellent sample.

The common bearded spring wheat of the French was at one time the most extensively cultivated spring wheat in France; and it comprises one variety with whitish grains and another with reddish grains. Its ear is small and more pyramidal than that of the light yellow bearded winter wheat; and its grain is shorter, and, in the case of the whitish subvariety, a shade lighter in colour.

The Tuscany straw-hat wheat, or *Froment blé de Toscane à chapeaux*, is a French modification of the Leghorn or true Tuscany, and very much resembles the common bearded spring wheat of the French, but grows rather taller, and is a shade yellower in colour when ripe; and it differs from the white bearded Tuscany wheat in both the ear and the grains,—the former being smaller and less compact, and the latter smaller, flinty, and of a light reddish colour.

The Cape wheat is also a French sort, and is reckoned by the French farmers one of their best spring wheats, but is found by them to be liable to degenerate unless the seed be often changed, and is also found to be more suitable for the south than for the north of France. Its ear is white and long; its awns are spreading; its spikelets are closer than those of most bearded wheats, and are also spreading; and its grain is larger, elongated, whitish-coloured, and generally plump, and forms rather a superior sample.

The small Sicilian bearded spring wheat differs from all the preceding varieties of bearded wheats, in the closeness of its ear, in the hard-like, smooth, shining appearance of its chaff, and in the shape and texture of its grain. Its ears are rather under the medium size; its awns are upright and longer than the ear; its spikelets are contracted, and slightly imbricated; and its grains are rather above the medium size, slightly elongated, and flinty.

Among other and more recently introduced white bearded spring wheats may be mentioned Colonel Le Couteur's early white spring wheat, the macaroni small hard wheat, the Naples white bearded wheat, the Tremoise black-jointed spring wheat, the Barbary hard chaffed wheat, and Gale's Hampshire wheat,—the last characterised by Colonel Le Couteur as "very enormously productive."

The velvet-eared or woolly-eared red bearded wheat is an early, hardy, prolific winter wheat, and might probably be found suitable as a spring wheat. Its ear is long, downy, rather compact, and of a dark reddish colour; its chaff is hard, and does not allow the seeds to be easily shaken by the wind; and its grains are large, flinty, and rather coarse.

The Victoria wheat, or Victoria red spring wheat, was observed by Humboldt in the neighbourhood of Victoria, in Caraccas, and was introduced thence to Britain by Sir R. K. Porter. In its native country, it ripens in 70 or 75 days from the time of sowing, and is very productive; and in an experiment, at Annat Garden in Scotland, it was sown on the 10th of June, and cut nearly ripe on the 16th September. Its straw is rather shorter than that of common wheats; its ears also are short, but pretty compact, and whitish coloured; its awns are spreading, and fully as long as the ears; and its grains are rather small, comparatively long, reddish-coloured, slightly cornered, and flinty.

The fern wheat began to be cultivated in the Carse of Gowrie in 1829; and, when sown there in the last week of March, ripens as early as any of the winter wheats sown in the previous October or November. Its ear is about 6 inches long, compressed, and of a light reddish colour; its awns are spreading, and considerably shorter than the ear; its spikelets are spreading, and very remote, and often contain each four grains; and the grains are elongated, of a bright light reddish colour, and rather flinty,—and they weigh at the rate of 63¼ lb. per bushel. This wheat is very liable to smut, and very apt to shake when over-ripe, and should not be allowed to stand beyond a state of moderate ripeness.

The red bearded Mendoza wheat was introduced to Britain from Mendoza by Sir John Sinclair. It bears a considerable resemblance to the fern wheat; but has stronger chaff, and larger and coarser grains.

The red Chinese wheat resembles the small Sicilian spring wheat in all its parts, except the colour of its chaff and grain, which are of a dark reddish hue.

Among other and more recently introduced red bearded spring wheats may be mentioned the Caucasian red wheat, the Capriola rosa red wheat, the Cape red spring wheat, the hedgehog red wheat, the Narbonne red wheat, and the transparent red wheat.

The Compact-Eared Cereal Wheats.—The compact-eared wheats are distinguished from the common-eared beardless wheats by the extreme shortness of their internodii, the compact setting of their spikelets, and the square form of their ears; and they constitute a group which almost all botanists treat as a distinct species, under the name of *Triticum compactum*. But they really are so closely allied to the common-eared wheats that they might fairly be viewed as a mere sub-species of them; and, in a sense, they actually comprehend all such common-eared wheats as are popularly called thicksets, or as have unusually short internodii or very closely set spikelets. "I have received specimens of compact wheat from France and Sweden," says Professor Low, "and have cultivated them without observing any change of characters. Whether, however, the characters which distinguish it are sufficiently permanent to entitle it to be regarded as a species, has not been determined; in the meantime, following the authority of Host, I have placed it amongst the species." Loudon represents it as a specific wheat introduced to Britain from Austria in 1819.

The Chili square wheat is one of the most marked varieties of compact-eared wheat. Its straw is white, very smooth, stiff, and upright; its ears are white, very smooth, upright, a little compressed on two sides, and seldom more than 1½ inch in length, and about ¾ of an inch in breadth; its spikelets are narrow, two or three seeded, and placed so remarkably close on their

rachis, about six to the inch, as to form with it an angle of about 45°; and its grains are small, elongated, and of a whitish colour, and amount to about 40 in each ear.

The small square spring wheat is also a very marked variety of compact-eared wheat. Its straw is stiff and upright; its ear is more square or less compressed than that of the Chili square wheat, of a brownish-red colour, stiff, upright, about 1½ inch long and ¾ of an inch broad; its spikelets are as closely set as those of the Chili square wheat, and considerably more spread, and generally three-grained; and its grains are small, slightly elongated, and well filled, and form a beautiful sample.

The square Sicilian spring wheat is reckoned by the French one of their earliest spring wheats. The awns on the point of its ear are elongated to rather more than the length of the spikelets, while those of the Chili square wheat and the small square spring wheat are almost a-wanting; and its grain is more flinty and has a brighter red colour than the grain of the small square spring wheat; but in other respects, the square Sicilian spring wheat and the small square spring wheat are very similar to each other.

Three other varieties of compact-eared wheat which have become known to British farmers, are the small square red wheat, the American square wheat, and the duck's-bill wheat; and Colonel Le Couteur says respecting the last of these, "It is very productive, but sheds greatly, and is not very farinaceous."

The Turgid-Eared Cereal Wheats.— Turgid wheat, *Triticum turgidum*, is a species containing many well marked varieties, comprising a considerable range or diversity of character, and connecting some compact-eared-like wheats on the one hand with the Egyptian wheats on the other. Awns are present in all the turgid wheats, but sit only on the corolla and not on the calyx; and, in most cases, they drop off or become easily detached by the winds when the plants ripen, and then leave them with a beardless appearance. The ears are compact, and become heavy and somewhat nodding as they fill with grain; those of some varieties are smooth, and those of others downy, woolly, or velvety with fine soft hairs; those of most varieties display four equal sides, and those of others have the attachment of the spikelets to the rachis on the two narrowest sides; and the awns and angles of most are arranged in four straight parallel lines. The spikelets are closely set, and generally much spread. The glumes have a greatly tumefied form, and very prominent dorsal nerves; and they terminate abruptly, and have acute points. The grain is large, crowded or compactly set in the ear, and irregularly angular-shaped or depressed; and it is hard, coarse, and of inferior quality, and forms but an indifferent sample. The turgid wheats are best suited to strong clay soils, rich tenacious soils, or stubborn and refractory argillaceous soils,—particularly such as occasion the common-eared wheats to become lodged, or as cannot well bear them to perfection; for the turgid wheats have such strong straw that, notwithstanding the heaviness of their ears, they can usually accommodate themselves to the stiffest soils, and vigorously resist the most prostrating weather. They have also the advantage of being decidedly productive in both straw and grain; and their straw, though too hard and firm and semi-solid to be relished by cattle, is admirably adapted, by these very qualities and by its length, for the purposes of thatching. The turgid wheats, however, generally belong to the latest class of winter wheats, and are suitable only to the earliest districts of Britain; and they will probably rather lose a good deal of the favour they have already attained, than acquire any more, among British farmers.

The Mongoke smooth white turgid wheat was introduced to Britain from the Continent by Mr. Lawson in 1833. Its straw is very long and almost solid; its ear is very large, white, and square, or has the lateral florets so pressed in as to render the aggregate form somewhat cylindrical; its awns are long, straight, and rigid; and its grains are long, irregularly shaped, large, white, and thick-skinned.

The Tagan rock smooth white turgid wheat is one of the earliest and most esteemed turgid wheats. Its straw is shorter, softer, and more hollow than that of the preceding variety; its ear is scarcely so long, and a shade darker in colour; its spikelets are not so close; and its grain has a yellowish-brown colour, seldom transparent or flinty, and is smaller and more regularly formed than that of most other kinds of turgid wheat.

The Lozere turgid wheat is much cultivated about Lozere, and is there often used, boiled or cooked, in the same manner as rice. Its ear is shorter, less closely set, and less regularly shaped than that of the Tagan rock smooth white turgid wheat; and its grain is whitish-yellow, thin-skinned, and of excellent quality.

The red smooth turgid wheat, the large red wheat, or the red upright wheat of Gatinais, is very much cultivated in the central districts of France. Its ear is long, square, compact, and of a dull reddish colour; its glumes are very smooth and shining; and its grains are soft, reddish, angular or slightly compressed on the sides, and of medium quality.

The Chinese turgid wheat, or Doragana wheat, was introduced from St. Petersburg in 1834. Its ear is white, large, square, very compact, and slightly pendulous; its glumes are shining and a little elongated; and its grains are rather large and flinty.

The cone wheat, white cone wheat, cone Rivet wheat, square wheat, pendulum wheat, antifly wheat, or German thickset wheat, is one of the best known and most esteemed turgid wheats in

Britain. It takes its name of cone from the somewhat conical form of its ears,—square, from the somewhat quadrangular setting of its spikelets,—pendulum, from the pendulous position of its ear as it approaches maturity,—and antifly, from its having almost wholly resisted the wheat-fly at a time when that insect worked great havoc among most other varieties of wheat. Its straw is long, strong, and hollow; its ear is very white and velvety, about 4 inches long and $\frac{3}{4}$ of an inch broad at the base, tapering towards the point, quadrangular, compact, and very regular; its principal awns are straight, about as long as the ear, and placed in four straight rows along the angles,—its subordinate awns rise in two rows from the outer paleæ of the middle fertile florets, and lie close on the ear,—and all generally break off when ripe, particularly in windy weather, leaving the whole ear apparently beardless; its lower and central spikelets contain each three or four fertile florets, and the upper ones generally two; its glumes and paleæ are short and very round, and the latter scarcely cover the seed when ripe; and its grains are soft, whitish yellow, a little compressed and wrinkled, and considerably larger than those of the ordinary common-eared wheats. This wheat is nearly a fortnight longer in ripening than the common white winter wheat; it is a vigorous grower, and is thought to be rather an impoverishing crop for the soil; it yields a scanty supply of foliage, yet is one of the most beautiful wheats when growing which can well be imagined; and, in favourable circumstances, it often yields several bolls of grains per acre more than the common wheats,—but the sample is inferior, and not well liked by bakers. It is found to answer best on strong clay soils.

The red, grey, or blue cone wheat, or red, grey, or blue Rivet wheat, bears a general resemblance to the preceding variety; but its ears have a reddish-blue or ash colour, and its grains are darker in colour than those of the white cone wheat, and rather more flinty. It is cultivated in England and the north of France, generally on strong clay soils; and it is very hardy in constitution, and very late in ripening.

The common Rivet wheat of England is cultivated on the strongest clay soils in the south of England, but is so late in arriving at maturity that it may be regarded as unfit for the north of England, or for any part of Scotland. Its ear is smaller and less compact than that of the white cone wheat; its awns are less liable to be broken off or blown away when ripe; its glumes and paleæ are considerably larger and more elongated; and its grains also are longer and more flinty.

The Pole Rivet wheat of England is also cultivated on strong soils in England, and is very late in ripening; and it is likewise much cultivated in the southern and eastern districts of France. Its ear has a lightish-brown colour, and is more compressed and irregularly shaped than that of the common Rivet wheat of England, and—contrary to the general rule of turgid wheats—it has the insertion of the spikelets into the rachis on its broadest side; its awns fall off when ripe; its lower spikelets contain each four fertile florets, and its upper ones three; and its grains are long, reddish, and flinty.

The Turkey wheat, or the Turkey great turgid wheat, appears to be a subvariety of the Pole Rivet wheat of England; and it is from a fortnight to three weeks later in ripening than the common white winter wheat. Its ear is larger, thicker, and more regularly square than that of the Pole Rivet wheat of England, and has a reddish-ash colour; and its grains are larger and of a darker colour, and form a rather coarse sample.

The St. Helena giant wheat, or St. Helena giant turgid wheat, was introduced to France from St. Helena, and reintroduced from Dantzic. Its ears are larger and more irregularly formed than those of the preceding varieties of the turgid wheats; its lower spikelets are more enlarged, and diverge in a zigzag manner to the sides; and its grains are large, about $3\frac{3}{4}$ lines long, flinty, and similar in quality to those of the Turkey wheat, but more prolific. This wheat also is late in ripening.

The Petanielle wheat, or Petanielle black turgid wheat, is distinguished among all the other turgid wheats for the height of its straw, the dark colour of its ears and awns, and the largeness and abundance of its grains; and it came into much demand about 16 years ago in the neighbourhood of Paris, and was introduced there from the south of France. Its awns fall off when ripe; its glumes and paleæ have a shining bluish-black colour; and its grains are harder and darker coloured than those of other turgid wheats, and at the same time possess all their peculiar defects.

The Egyptian wheat, Egyptian cone wheat, Abyssinian wheat, Smyrna wheat, reed wheat, compound-eared wheat, or branching-eared wheat, is sometimes undistinguishable from the ordinary turgid wheats, but at other times has a ramified or compound ear of a form as if several ears were tied together, and is therefore treated by most botanists as a distinct species under the name of *Triticum compositum*. It certainly is almost unique in the property of producing a compound ear; but it by no means possesses this property essentially or constantly; and seems merely to be a true turgid wheat in poor or ordinary circumstances, with a constitutional power of developing compound ears on rich soils or under good or favourable conditions of culture. Its straw is stiff, long, and nearly solid or filled with pith; its glumes and paleæ are slightly downy, and have a glaucous reddish colour; and its grains are short, whitish-brown, and rather flinty. Its produce in grain is very abundant under favourable circumstances of soil, climate,

and culture; but its grain yields a smaller proportion of flour or meal than most other kinds of wheat; and its flour is scarcely superior to that obtained from the finest barley. It is cultivated in Egypt and in the south-east of Asia; it has been known in Germany for about 250 years, and cultivated in France for about 80 or 90 years; it was introduced to Britain from Egypt about the end of last century; and it has been experimentally cultivated, under different names, in various parts of both England and Scotland; but it does not seem to be well suited to British agriculture,—for it is very liable to be laid, it is retentive of moisture at the time of harvest, it does not display any such luxuriance and productiveness here as it does in other countries, and it is decidedly objectionable on account of the qualities of its grain and flour.

Three other varieties of turgid wheat which have become known to British agriculturists are the Losanna red turgid wheat, Mumford's gigantic wheat, and the American thumb wheat; and the first and second of these are always single-eared, while the third possesses the peculiar earing habit of the Egyptian.

The dark-eared or dark-headed wheat, though usually classed by botanists as a separate species under the name of *Triticum atratum*, is also sufficiently akin to the cone wheats to be regarded as a mere variety of *Triticum turgidum*, though at the same time it has some affinity to the *Triticum spelta*. It was introduced to Britain from Austria in 1820; and has been made the subject of some comparative experiments; but does not recommend itself to cultivation by any properties or habits of superiority to the Rivet wheats of England.

The Compressed-Eared Cereal Wheats.—These comprise the stiff, hard, or hairy wheats of botanists, constituting the species *Triticum durum*. They are characterized by large, broad, compressed ears, generally very short in proportion to their breadth,—by elongated spikelets,—by large, hard-like, shining chaff,—and by long-shaped, hard, and flinty or horny grains; and all are awned, and have stiff, short, upright straw, and broad foliage. "These wheats," says Mr. Lawson, "are in general very early, and may be sown in spring. Their cultivation has been several times attempted in Britain, but with little success, owing partly, no doubt, to the unsuitableness of our climate, and partly to their peculiar hardness, and, in the estimation of our bakers, inferiority of their samples. The chief range of their cultivation lies along the shores and in the islands of the Mediterranean, and along the shores of the Levant, as also in Arabia, Persia, and some parts of India. The Arabs cook some of them in the same manner as they do rice, which they all resemble in the hardness of their grain. Wheats of this sort are often imported for the London markets, but were at first very much disliked by millers, from the ordinary millstones being unsuitable for grinding them."

The hard Sicilian wheat bears some slight resemblance to the common-eared wheats, and may be regarded as forming a connecting link between the compressed-eared wheats and them, through the medium of the small Sicilian bearded spring wheat. Its ear is about 3 inches long and $\frac{1}{3}$ of an inch in diameter, and has a square form approaching to cylindrical; its awns are considerably longer than the ear; its glumes and paleæ are long, smooth, white, and shining; and its grain has a lightish-red colour, and is medium-sized, elongated, hard, and horny.

The Georgian wheat is much more strictly a compressed-eared and hard-grained wheat than the preceding. Its straw is short, upright, and quite solid; its ear is compact, sub-cylindrical, a little irregular toward the base, about 2 inches long, and from one-half to five-sixths of an inch in breadth; its spikelets are long and pointed; its awns are about twice as long as the ear; its glumes and paleæ are long, whitish, and slightly downy; and its grain is about one-third of an inch long, less than one-sixth of an inch in diameter at the middle, slightly triangular, curved towards the ends, of a light red colour, and very hard and flinty or horny.

The Siberian wheat has considerable affinity and resemblance to the Georgian wheat. But its straw is a little hollow; its ear and spikelets are shorter and more compact than those of the Georgian wheat, of a light brownish colour, and more distinctly downy; and its grains are rather shorter, and equally hard and flinty.

The Morocco or Tangier wheat has hard, upright, and generally hollow straw, a larger and more irregularly shaped ear than either the hard Sicilian, the Siberian, or the Georgian wheat, and grains of the same colour and hardness as these wheats, but of larger size. "This sort," says Mr. Lawson, "together with several more varieties in mixture, differing from it chiefly in colour, was sent to this country several years ago by the British Consul at Tangier; they were tried in several parts, but their cultivation has been abandoned, or they are only to be met with in collections."

Three other kinds of hard wheat which have become known to some British agriculturists are the Ishmael wheat, the Manfredonia wheat, and Dr. Rolland's Nepaul hard wheat; and the last of these differs so far from the rest as to make some slight claim to be considered a different species, or at least a very distinct variety.

The Loose-Eared Cereal Wheats.—These are the Polish wheats, constituting the botanical species *Triticum polonicum*. But though generally termed Polish, they really are natives of various parts of Africa and south-eastern Asia; and they are also popularly called wheat of Cairo, Mogadore wheat, Grecian wheat, Polish rye, and Astrachan rye. They are readily distinguished from all

other wheats by their long, loose, and chaffy-like ear, and by their large grains. The ear is awned, and nods to a side; the awns are about three times as long as the glumes, and very brittle, and easily break off when ripe; the glumes are more than an inch in length, or twice as long as the florets; four florets are contained in each spikelet, and seldom more than two of them, when the plant is grown in this country, are fertile; and the grains are about half an inch in length, of a reddish colour, transparent, and very hard. Polish wheat is cultivated in Africa, some parts of Asia, Spain, Germany, and Poland; and it was introduced to Britain so long ago as the latter part of the seventeenth century, and has been subjected in this country to a great many experimental trials, and has been thought to be valuable on account of its productiveness of flour; but it is too tender in constitution, and too extensively subject to infertility in our climate, to be ever likely to become a favourite with British farmers.

The Meagre-Eared Cereal Wheats.— These are wheats with small, thin, slender, or otherwise comparatively inconsiderable ears, of medium character between the ears of the bulky cereal wheats and the ears of the mere wheat-grasses; and they comprise, among other kinds, the species called zea or far, Bengal wheat, starch wheat, and one-grained wheat.

The zea or far, *Triticum zea*, is the spelt wheat, or *Triticum spelta*, of Host and some other continental writers; and it is popularly supposed, though we think quite erroneously, to be the grain termed zea by the Greeks and far by the Romans. Its straw is rigid; its ears are long, almost awnless, thin, and upright; its spikelets are not so long as two joints of the rachis, and are so firmly attached to the rachis, that, in thrashing, they do not separate from it but break it, each spikelet retaining a joint; its florets on each spikelet amount to three, and the middle one is barren; its glumes and paleæ adhere almost as closely to the grain as the spikelets do to the rachis; and its grain is elongated, triangular, reddish, and flinty. This wheat is cultivated on inferior soils in some parts of Continental Europe; but is seldom met with in Britain, except in botanical collections.

Bengal wheat, *Triticum Bengalense*, was introduced by Mr. Lawson from Germany in 1834. "It bears some resemblance," says Mr. Lawson, "to the *Triticum zea* in the shape and remoteness of its spikelets, which adhere with equal firmness to the rachis; the straw and ears are, however, much longer, the latter containing about thirty-six grains, which are longer and more easily detached from the chaff than those of *Triticum zea*. It is of a more luxuriant growth, and has an awn from two to three inches in length. This is altogether a much superior variety to *Triticum zea*, and is remarkable as being the earliest wheat in the whole (of the Highland and Agricultural Society of Scotland's) collection."

Starch wheat, *Triticum amyleum*, is the spelt wheat or *Triticum spelta* of most British botanical authors; and it is both far more varied in character and far more economically useful than the *Triticum zea*. "Spelt," says Professor Low, "is much cultivated in the south of Europe; it is grown extensively in the southern provinces of France, in Switzerland, Italy, in several parts of Germany, and in Arragon, Catalonia, and other parts of Spain. Spelt could be raised in this country with facility, and, it is probable, on soils low in the scale of fertility; it has been cultivated in Scotland 600 feet above the level of the sea." Its specific characters are compressed, awned, slender ear,—long, smooth, overlapping, or closely imbricated, three-floreted spikelets, with generally but two perfect seeds,—adhering rigid chaff, similarly persistent to that of the zea and the Bengal wheat,—and long, irregularly triangular, reddish, transparent, but not hard grain. It comprises winter and spring, long-eared and short-eared, whitish and brownish varieties; and in cases where its chaff is red, its grain has a correspondingly darker colour. The root-leaves of the winter starch wheat or winter spelt are narrow and prostrate; the ear is long and slightly bent to one side; the spikelets are each about as long as three joints of the rachis, and contain generally two but sometimes three seeds, especially toward the base of the ear; and the chaff is whitish, rigid, and shining. The spring or summer starch wheat, or spring or summer spelt, differs little from the preceding, except in having stronger or more upright root-leaves, and in ripening about 10 or 14 days earlier. The ear of the red two-rowed starch wheat or spelt, or brown two-rowed starch wheat or spelt, is of a reddish-brown colour and slightly glaucous, particularly before ripening; and its grain is a shade darker in colour than that of the two preceding varieties. The ear of the white broad-spiked starch wheat or spelt is considerably shorter, much broader, thicker, and more compact than that of any of the three preceding; and its spikelets are more frequently three-grained, and about as long as four joints of the rachis. The ear of the red or brown broad-spiked starch wheat or spelt resembles that of the white broad-spiked in form, but has a reddish-brown colour, with generally more or less of a glaucous or bluish hue, particularly before ripening. "Amongst the Alps of Switzerland," says Mr. Lawson, "the winter spelt is found to withstand the severest winters, at altitudes far above that at which the range of the naked or commonly cultivated sorts terminate. And, independently of its grain, it might be substituted as an herbage plant for yielding a crop of green food for cattle early in spring, in late cold districts, from its tillering well, and yielding a considerable quantity of foliage. It is sown in October, and the spring

sort in February or March. The flour of the spelt wheats contains more gluten than that of the common sorts; it makes a superior very white bread, and is much used by confectioners for pastry."

The one-grained wheat, *Triticum monococcum*, is allied to the spelts, and is cultivated, on poor soils, in the mountainous parts of Continental Europe; and it was introduced to Britain so long ago as about the middle of the seventeenth century. Its straw and leaves are very small and rigid; its ears are small, very much compressed, and two-rowed in a manner similar to common barley; its spikelets are close, imbricated, and about as long as four joints of the rachis; each spikelet contains only two florets, the one fertile and long-awned, the other barren and short-awned; and the grain is small, triangular, transparent, soft, and mealy. The flour of this wheat makes a good dark-coloured bread, but is more particularly adapted for gruel. "The one-grained wheat," says Mr. Lawson, "is equally hardy with the spelt wheat, but far inferior to it in quality and produce; however, it thrives on the poorest, dry, calcareous, sandy soils where few other of the cereal grains would subsist, and yields straw, which, although short, is, from its firmness and durability, well adapted for thatching; for which the straw of the spelt-like wheats in general seems much better adapted than for fodder."

Comparative Trials of Different Wheats.—Peculiar kinds of wheat suitable for particular soils, particular situations, particular times of sowing, and particular purposes, are so comparatively few in number and so comparatively marked in character as to occasion little difficulty of selection, and sometimes not even to allow any alternative for choice; while kinds which possess only indistinct peculiarities, and are suitable for ordinary soils, ordinary situations, ordinary times of sowing, and the most ordinary purposes of culture, are so aggregately multitudinous and so individually ill-defined, as often or even usually to render it exceedingly difficult, on any one farm or in any one district, to select such as may prove most profitable. Thus, if an inexperienced farmer wish to ascertain the most suitable wheat for an excessively stiff soil, or for a poor soil, or for a cold or elevated situation, or for sowing at the latest possible period in spring, or for the best thatching adaptations of the straw, or for the most glutinous qualities of the grain, he may readily discover it, and will be liable to scarcely any hesitation or mistake in doing so, simply by perusing the brief accounts of the principal kinds in our six preceding sections; but if, on the other hand, he wish to ascertain the kind which will best compensate him by ordinary routine cultivation on any kind of good low-lying farm of the mixed husbandry, whether the soil be clay or loam, whether the time of sowing be autumn or spring, and whether the main consideration be the grain alone or both the straw and the grain, he may at first feel rather hindered than helped by the accounts which we have given, and may in a little while feel himself more confounded than instructed by the display of many kinds, all seeming to compete with one another for superiority,—and, if he seek relief from his perplexity by an appeal to the opinions or usages of his neighbours, he will, in almost every case, be either thrust deeper into difficulty or driven back on the guidance of mere empiricism or chance. Though numerous varieties of prime or very good wheats seem to be very nearly equal in value, and though all have necessarily been described by us under determinate characters which were severally assigned to them under circumstances of apparently normal development, yet all differ more or less widely from one another in such constitutional habits and minute adaptations as most materially affect their comparative value on any one farm, and each differs more or less widely from itself in the younger or older stages of its existence as a variety and in the greater or less congeniality of the circumstances of its culture. Hence, a variety which is of prime-rate profitableness under one set of circumstances of climate, soil, manure, rotation, sowing, and tillage, may be only second-rate or fifth-rate or tenth-rate profitable under a different set of these circumstances; and a variety which was eminently productive in any given circumstances when it was young, may become very inferiorly productive in exactly the same circumstances when it turns old. Every extensive cultivator of ordinary market wheat, therefore, ought to find out for himself the varieties which best suit the conditions of his own farm and farming; and this he will do either by ascertaining the result of comparative experiments conducted by some intelligent neighbour under precisely similar conditions, or by instituting a set of such experiments himself. The latter is the more satisfactory method; and may easily be done simply by selecting all the seemingly prime kinds which promise to be suitable for the soil and culture, and by planting equal surfaces of ground with each at such depths and distances as will afford all the fullest play for their utmost possible luxuriance. As examples of the kind of way in which experiments should be conducted, and of the nicety and diversity of the results which may be ascertained, we shall here insert reports of two admirable experiments by respectively Mr. John Morton and W. Miles, Esq., M. P.

"The intelligent farmer of arable land," says Mr. Morton, "expects a greater crop, the more he has been able to improve the texture of the soil, and the better the nature and state of the manure which it contains. He expects it, because he knows that it depends on the nature of the food given to the plants, and the manner in which they are provided with a constant supply of it. The crop does not, however, depend only on this; for as two beasts fed in exactly the same manner may not be equally pro-

fitable, owing to a difference between them regarding the quantity and quality of the meat they afford, so two different kinds of wheat, though sown on land precisely similar, and in equally good condition, may give unequal returns, owing to a difference between them regarding the quantity and quality of the flour they afford. Hence the importance, too often overlooked by farmers, not only of preparing the land for the crop in a good and sufficient manner, but also of selecting that kind of seed which experience has pointed out as being most valuable and productive. It was with a view, not only of ascertaining the relative value, hardiness, and other properties of several of the most commonly-planted wheats, but also of effecting an improvement in the best of them, that the following experiment was commenced on the 1st of November 1837. To insure accuracy in the results, it was necessary that the seeds of each variety should be planted so as to have them all at equal distances. To effect this, two boards were used, each six inches wide, nine feet long, and half an inch thick. Along the centre of each board was a row of holes, three inches apart and one inch in diameter. A dibble was made to fit into the holes, having a shoulder at the distance of 2½ inches from the point. When the board was placed on the ground, and the dibble put through each hole in succession, a series of holes was thus made, two inches deep, and three inches apart from centre to centre. After this had been done through the first board, the second, which was touching it, and parallel to it, was served in the same way; and then the first was taken up, and placed on the other side of the second. By proceeding thus, the whole ground was finished, and then one grain of wheat was dropped into each hole. The rows were thus exactly six inches apart, and the grains in the rows were three inches from one another. The regularity with which the planting was performed was thus mathematically accurate. The ground planted lies on the lower edge of the great oolite formation, and the soil is a stone-brash, about ten inches in thickness. Crops of potatoes had been taken off it for a succession of eight years; and it had been manured every alternate year, with a compost of equal bulks of stable-dung and earth, at the rate of about twenty cubic yards per acre. It was sixty-seven feet in length; and three rows of each variety of wheat were planted, except the first and last numbers, of which there were four rows. The outer row of each of these, however, was not taken into account, because their roots had a much greater extent of ground for their growth than the others, whose roots touched one another all round. The end plants of each row were also rejected for the same reason. Sixty-six feet in length of ground were thus taken up, and three rows of each variety occupied in width 1½ foot: the ground occupied by each variety was thus ninety-nine square feet, the 440th part of an acre.

When planted.	No.	Name of Wheat.	Whence obtained	No. of Seeds planted.	Loss of Seeds from Birds, Frost, &c.	Produce of 99 sq. Feet. Plants or Roots.	Produce of 99 sq. Feet. Heads of Grain.	No. of Ears in One square Foot.	Average No. of Heads per Root.	Weight of Grain produced from 99 square Feet.	Weight of Wheat per Acre.	No. of Bushels per Acre, at 64 lbs. per Bushel.	Length of Straw.	Weight of Straw produced from 99 square feet.	Weight of Straw per Acre.	Weight of Roots with 2 in. of Stem.	Weight of Roots per Acre.
Nov										lbs.	T. ct. qr. lb.		ft. in.	lbs.	T. ct. qr. lb.	lbs.	T. ct. qr. lb.
15	1	Old red Lammas.	Pusey, Berks.	792	387	405	2463	25	6	6	1 3 2 8	41¼	5 8	16½	3 5 2 24	5	0 19 2 6
..	2	Golden drop	- -	792	291	501	2542	25	5	6½	1 6 2 8	46¼	5 6	15¼	3 0 0 3	5¼	1 0 2 14
..	3	Ten-rowed prolific.	Hareby, Lincolnshire.	792	391	401	1935	19	3½	4½	0 16 2 16	27	5 5	12¾	2 10 0 10	5	0 19 2 6
..	4	Hunter's.	Leek, Lincolnshire.	792	273	519	2028	20	4¼	4½	0 16 2 16	27	5 6	12¾	2 12 0 10	5	0 19 2 6
..	5	Thick-set Suffolk.	Lyford, Berks.	792	120	672	3039	30	4½	10¾	2 1 1 0	72¼	5 8	19½	3 5 2 14	7½	1 9 1 24
..	6	Hickley's prolific.	Old Buckingham, Norfolk.	792	132	657	2886	29	4½	10¼	1 19 3 3	69½	5 7	16½	3 5 2 24	6¼	1 6 2 8
16	7	White Taunton.	Wallingford, Berks.	792	305	487	2695	27	5¼	6	1 3 1 20	41¼	5 6	15¼	3 0 0 0	5½	1 1 2 12
..	8	Silver drop.	Lyford, Berks	792	218	574	2582	26	4½	8	1 11 1 20	55	5 6	18½	3 12 2 12	6	1 3 2 8
..	9	Scotch white.	- -	792	379	413	2386	24	5¼	6¼	1 4 2 6	43	5 9	16½	3 5 2 24	5½	1 1 2 12
..	10	Talavera.	Taunton.	792	434	358	1985	20	5½	5¼	1 0 2 14	36	5 8	14½	2 16 3 14	5½	1 1 2 12
21	11	Smithers' Hereford white.	Cirencester (Smith).	792	319	473	2529	25	5¼	9½	1 17 1 8	65½	5 6	17½	3 8 3 20	5	0 19 2 0
..	12	A red wheat.	- -	792	252	540	3453	35	6½	12	2 5 1 12	82½	5 0	22	4 7 0 2	9	1 15 2 6
..	13	Egyptian cone.	- -	792	528	264	1711	7	2½	3¼	0 13 0 24	23	6 0	8¼	1 11 2 2	3	0 11 3 4
..	14	Red straw Lammas.	- -	792	510	282	2096	21	7½	4½	0 16 2 16	27	5 8	14½	2 16 3 4	5	0 19 2 6
..	15	Blue cone.	- -	792	264	528	1626	16	5	6	1 3 1 28	41⅛	6 0	9¼	1 16 1 16	6	1 3 2 8
..	16	Red cone.	- -	792	456	336	2446	24	7	10	1 19 1 4	68¾	5 3	12⅔	2 9 0 0	4¼	0 18 2 10
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Although the tabular form in which this experiment is detailed explains itself by the headings of each column, yet it is considered necessary to give a somewhat fuller account of it. The seed from which the first ten varieties were raised was carefully selected from specimens of each obtained in the ear. The others were from samples; and here, also, the greatest care was taken that the seed from which each was raised should be the best and plumpest that could be obtained. The first five columns need no explanation beyond what is given at the head of each; the sixth shows the number of grains lost from casualties. If the frost had been the only agent in the destruction of so many of the seeds, this column might have been considered as a very accurate index of the relative hardiness of each variety. This, however, is not the case, for the havoc which the birds made must also be taken into account. It was thought, at the time, that more injury was sustained, from the latter cause, by those varieties planted on the 21st, than by any of the others; but this does not appear to have been the case, for, if the

great loss sustained by these had been wholly owing to the havoc committed by the birds, it is evident that the varieties marked Nos. 12 and 15, would not have been so slightly injured, while Nos. 11, 13, 14, and 16 suffered so severely. The figures in this column may, therefore, be said to indicate with tolerable accuracy the relative ability of each variety to withstand the effects of a severe and changeable winter, such as that during which the experiment was made. The number of plants of each variety which came to perfection, is placed opposite the name of each in the seventh column. This was ascertained by pulling each as they respectively ripened, and counting the plants of each before proceeding to the others. In this way, by a simple subtraction, the numbers contained in the sixth column also were ascertained. When all the plants of any variety had been pulled, the number of ears also belonging to them was counted, and the results are placed in the eighth column. By dividing these by ninety-nine, the number of square feet which each variety occupied, we obtain the number of ears in each square foot; and this is placed opposite the name of each wheat, in the ninth column. The average number of ears to each root, ascertained by dividing the number of ears by that of the roots, is placed in the tenth column. This column shows the degree in which each species possesses the important property of spreading and shooting out stems, or, as it is technically termed, of tillering; and it will be seen that they vary in this respect greatly. After having been pulled and dried, the wheat was carefully rubbed out; and after the light and imperfect grains had been separated, the weight of the remainder was taken, and placed opposite each sort in the eleventh column. The thirteenth column contains the number of bushels per acre raised from each variety. As the quantity produced was so small, there was some difficulty in obtaining the particulars which this column contains. The mode adopted was this. The average weight of several of the varieties was ascertained by weighing eight pints of each, to be at the rate of sixty-four pounds per bushel, some being rather more, and others less. The number of bushels were then obtained from the weight of wheat per acre, by dividing it by sixty-four. The weight of straw, which is placed in the fifteenth and sixteenth columns, was ascertained after the roots had been cut off, and after it had remained out sufficiently long to dry it perfectly. After the earth had been removed from the roots, which had been cut off with about two inches of the stem, they were weighed, and the result placed in the seventeenth and eighteenth columns. The object of this was to ascertain the amount of vegetable matter left in the soil after the wheat crop has been removed, and the result greatly exceeds any conception of it that had been previously entertained. The inferences which, it is presumed, may be drawn from the above details, are the following:—1st. With regard to the hardiness of the varieties, which, as we have already said, may, to a certain extent, be deduced from the particulars contained in the sixth column, that they may be placed in three classes,—Nos. 5. 6. 8. 12. 15. 4. and 2. being the hardiest; Nos. 13. 14. 16. and 10. being the most delicate; and Nos. 1. 3. 7. 9. and 11. occupying an average station. 2d. With regard to the property of tillering, of which we have already spoken, that Nos. 12. 14. 16. and 1. possess it in the greatest degree; that Nos. 3. 13. 4. 5. 6. 15. 8. and 2. possess it in the least; and that Nos. 7. 9. 10. and 11. hold a medium rank. 3d. That with respect to the relative value of each variety mentioned in the table, No. 12. is undoubtedly the best of any, in productiveness, and in being sufficiently hardy; that No. 13. is as undoubtedly the worst of any, as will be seen by a reference to any of the columns; and that the others vary greatly, some possessing nearly three times the productiveness of others."

"In Sept. 1841," says Mr. Miles, "I chose for my experiment a one-year old clover ley, on a sandy loam, gently sloping to the north-north-west. The crop of clover had been very good, nearly 50 cwt. an acre; from some part of the field I had taken a second crop, feeding the remainder with sheep and young beasts; no visible difference, however, was afterwards apparent in the grain crop, either in quantity or quality, from these distinct modes of treating the second crop of clover. The field was ploughed on the 20th of September, and, having been laid out in half-acres for the ploughing-match of the Bath and West of England Society, was continued in the same state for the experiment, each half-acre being separated by 27 inches of grass-balk. The sorts selected for trial were, of white wheats, No. 1, Bellevue Talavera, No. 2, Chidham, No. 3, Silver drop, No. 4, a seedling—Jonas's prolific, No. 5, Sheriff's, and No. 6, golden swan; and of red wheats, No. 1, Burwell, No. 2, red champion, No. 3, Britannia, No. 4. Mr. Fisher Hobbs's red marigold, and No. 5, old red Lammas. To each of these wheats 3 half-acres were allotted, except to Mr. Jonas's seedling, of which I had but sufficient seed for an acre: the quantity sown per acre was 2 bushels and 1 peck. On the 27th of September, previously to breaking up the clover, 10 bushels of ½-inch bones were sown broadcast over the field. On Tuesday the 12th of October, I commenced putting in No. 1 white with a Suffolk drill, and finished No. 5 red on the Friday following. On Tuesday the 26th No. 2 white appeared; on the following Saturday all the whites were up; on the 3d of November the red wheats were partially, but without any apparent priority of germination, showing. The appearances of the white wheats were—No. 1, sixth; No. 2, first; No. 3, fourth; No. 4, third, No. 5, fifth; No. 6, second. No. 1 came up very indifferently; indeed it seemed, from the incessant rains, which had continued almost without intermission from the time of sowing to this period, to have perished in the ground; and as this wheat never afterwards improved, but was entirely hoed in again in February, it may be considered as having totally failed with me. Last year, however, in which there were several very sharp frosts and a good deal of catching weather, I reaped a most capital crop of Bellevue Talavera, nearly 5 quarters an acre, which had been sown in October, 1840. This wheat in our climate I consider essentially a spring wheat, and as such invaluable; for in the parts of the trial-field this year where the plant was very deficient, or had totally failed, I hoed it in from the 6th of February to the beginning of March, and the wheat so sown was ready for the sickle as early as those sown in October. On the 21st of November I found the appearances of the wheats thus noted:—Whites, No. 2, third; No. 3, fourth; No. 4, second; No. 5, fifth; No. 6, first: Reds, No. 1 and 2, first; No. 3, fourth; No. 4, second; No. 5, third. The first fortnight in January was very trying to the plant, as we had alternate sharp frosts and sudden thaws without snow. On the 22d the wheats were going off terribly, and the wire-worm was general in its ravages: I immediately put the heaviest roller I could get on the field and rolled it till the surface was as hard as a turnpike-road; still the damage apparently done was immense, and a neighbouring farmer guessed that the product of the field would not be above 16 bushels per acre: the rolling, however, stopped the progress of the wire-worm. On the 5th of February I began hoeing in Bellevue Talavera on those spots of the trial-pieces where the plant had nearly disappeared: of the whites the whole of No. 1 was put in afresh; of No. 5, about two-thirds of an acre: of the reds a little was put in in Nos. 1 and 2; nearly all in No.

3; and about half an acre in No. 5: so that of the white wheats Nos. 2, 3, 4, and 6, and of the reds, No. 4, were the only wheats which stood the winter for crop as first planted. On the 2d of April I find that the wheats on the whole were very bad; but from the 25th of March until the 23d of April, not sufficient rain fell at King's Weston to wet the ground, and at this period the wheats began to mend; their improvement being gradual, but extraordinary. I was absent from home during the blooming, but was informed by my farming-man that very little difference was perceptible between the flowering of the whites, and that the reds came into bloom from a week to ten days after the whites. On my return from London at the end of the first week in July, I found the general improvement still progressing; the tillering, considering the nature of the soil, had been extraordinary, and the ears were upright and full: I therefore carried out the experiment as far as was practicable, selecting 16 perches from each variety, cutting it with the scythe, and accurately weighing the grain and straw. On the 2d of August I marked out, as nearly as my eye could enable me to judge, 16 perches of average equal growth and occupying relatively similar positions in the field, from Nos. 2, 3, 4, 5, and 6, white; and from Nos. 1, 2, 4, and 5 red, similar quantities, but, excepting No. 4, not in relative situations to the white wheats; yet still, had the season been generally favourable, such 16 perches as I estimated would have been fair samples of the produce of these wheats. The white wheats, however, throughout appeared better suited to my land than the reds; and the result of the experiment has convinced me that, in soil and climate similar to that on and in which I have made the trial, the growth of the former should be encouraged rather than the latter. Before reaping, the appearance of the different wheats was as follows:—Whites, No. 2, third; No. 3, fourth; No. 4, first; No. 5, third; No. 6, second: Reds, No. 1, third; No. 2, second; No 4, first; No. 5, fourth. For the reason before specified, viz. the almost total destruction of the plant of No. 3, no portion of that wheat was measured off for the experiment. On Friday the 5th of August I cut with the scythe the whites, on the Monday the reds, and on the following Wednesday and Thursday carted the respective lots. The subjoined Table will show the results of the produce of wheat-straw and flour per acre of each kind, estimated from the product of 16 perches of each. I conceive, however, that, were the whole of the produce of each sort to be thrashed out, none of the crops would come up to this average; but the appearances of Nos. 4 and 6 white, and No. 4 red, were generally good, and the tabular results would not at most give 2 or 3 bushels per acre above their respective produce. Every attempt, however, as far as the season permitted, has been made to carry out the experiment with perfect fairness. I consider for the bulk of straw the yield of grain was extraordinary, and the samples of wheat of each kind can scarcely be surpassed, subjected as they were merely to the usual dressing. The miller declared that he had never ground better flour; but stated that, if he had any preference, he should give it to No. 2 white, and No. 1 red. In the process of converting the flour into bread, better than which I never have tasted, the plan recommended by Colonel Le Couteur was adopted, viz. '18 lbs. of the flour of each sort was placed to rise or sponge over-night with ½ a pint of yeast and 2 quarts of water. At nine o'clock the next morning 4 oz. of fine salt were added, together with as much water, milk warm, as each kind would imbibe to fit it for the oven, which was well worked up, *drawn up* (as it were) into strings to expose it to the air as much as possible in order to render it light, left to rise for 20 minutes, or ½ an hour, baked and weighed next morning.' The subjoined tabular statement will, I think, prove the necessity of carrying out all our experiments to the utmost, as otherwise great danger will arise of discarding valuable sorts, merely from their being in one or two instances less productive than others, which may be accounted for from the chances of the season, or other disturbing, but not sufficiently investigated, causes. Of the white breads No. 6 was the whitest, No. 4 the closest, and No. 2 the lightest; of the brown, or rather that made from the reds, No. 5 was the whitest and lightest; the others were much the same in colour and quality.

Numbers of Wheats.	Weight per Bushel.		Produce per Acre, estimated from 16 perches, cut, weighed, and thrashed by hand.			Weight of Straw per Acre, similarly estimated.				Weight of best Seconds Flour per Acre, estimated from 2 bushels of each.	Weight of Gurgeons and bran, do. do.	Quantity of Water imbibed by each sort in working up.		Quantity of Bread from 18 lbs. of Flour, of each sort.	
			Head. Bush.	lbs.	Tail. lbs.	Tons.	cwt.	qrs.	lbs.			Qts.	pints.		
	lbs.	oz.								lbs.	lbs.			lbs.	oz.
W. 2	62	11	32	60	44	1	8	0	24	1707	389	2	0¼	26	2
W. 3	63	0	32	0	40	1	0	0	0	1699	328	1	1¾	24	14
W. 4	62	8	43	24	40	1	7	0	11	2229	499	2	0½	23	11
W. 5	62	5	34	22	53	1	8	3	10	1683	489	2	0	24	1
W. 6	63	11	32	7	43	1	7	0	24	1700	369	2	0½	25	10
R. 1	64	0	28	39	62½	1	3	2	23	1588	348	1	1½	23	14
R. 2	62	5	38	17	60	1	7	2	20	1894	459	1	1¾	24	0
R. 4	62	5	32	25	30	1	4	1	14	1646	348	1	1¼	24	8
R. 5	62	11	31	42	44½	1	4	0	12	1583	380	2	0	25	4

It will be perceived that No. 4 white was by far the most productive of the trial wheats; and as Mr. Jonas, when he presented this prolific seedling to me, sent me an account of its origin, I think I cannot do better than insert an extract from his letter, as it may encourage farmers, should they accidentally discover amongst their crops ears of corn of extraordinary productiveness, dissimilar to the bulk of the crop, and of apparently new habits, to preserve and cultivate such more generally than they do at present, for the purpose of raising valuable varieties. Mr. Jonas thus wrote in September, 1841:—'You will oblige me by accepting 3 bushels of white wheat, which I have raised from a single ear, and by growing it side by side with the trial-wheats of Liverpool. I have no fear of the result; but should the Liverpool selected wheats be more prolific and valuable than mine, I shall be highly gratified, as I should cease growing the sort I have thus raised and have some of that which was better. I would thank you not to sow this wheat before the latter part of October, or the beginning of November, as it is inclined to tiller early. I send you the exact quantities grown each year from this single ear, and I do so that you

may avail yourself of any opportunity or way you please of showing to my brother-farmers how short a space of time is required to raise a good sort of any grain,—

Years.			Produce.
1838 dibbled in 50 kernels (30 of which only grew)			14¾ oz.
1839	„	„	14¾ oz. „ „ 1 bush. 1 peck
1840	„	„	1 bush. 1 peck „ 45 bush.
1841	„	„	45 bush. „ „ 537 bush.

And had this wheat not been as much red-gummed as my other sorts, I believe I should this year have had 100 bushels more.'"

Soils and Tillage Suitable for Wheat Crops.—The soils most suitable for wheat are the argillaceous; and so peculiarly suitable are these as often to be comparatively termed wheat-soils; and they owe their suitableness partly to their comparatively firm mechanical texture, and partly to their comparative richness in alkalies and salts. The soils least suited to wheat are either such spongy or excessively porous ones as do not afford sufficient anchorage to the roots of the plants, or such extremely light ones, whether silicious or calcareous, as do not contain enough of saline matter for the secretions of the culms and the ears. Yet some clay lands are either too stiff or too plastic to be eminently or even moderately suitable without being ameliorated by means of draining, textural manuring, and very thorough tillage; and almost all light arable soils, except the very worst, provided they enjoy sufficient amenities of climate, are capable of being rendered suitable by means of claying, marling, or some other special preparation, combined with appropriate tillage and with judicious rotational management. The production of wheat, indeed, ought never to be forced on any land which may be more profitably devoted to other crops; yet, whenever it promises superior profit on land which is naturally unsuitable, it can easily be rendered practicable by means of due preparational appliances. Proper management in prospect of wheat crops, therefore, whether as to the selecting of land, as to the general rotation, as to the preceding crop, as to the preparatory tillage, or as to the prospective or immediate manuring, must exceedingly vary according to circumstances, and requires the exercise of a clear and comprehensive judgment; and, in a general view, subject to variations and exceptions, and aimed more at making suggestions to intelligent farmers than at giving any very detailed instructions to ignorant or unreflecting ones, and based principally on a review of the best existing practices, without any predominant bias from theory or from untested science, it will be found very well stated in the following long extract from a recent Prize Essay by Mr. Edward Roberts, in the 8th Volume of the Royal Agricultural Society's Journal:—"Whatever may be the nature of the soil, it should always be the aim of the farmer to grow full crops: partial and sometimes extensive failures will even then but too often occur; but to neglect making the best-known preparation, or only to prepare for half a crop, is an ill-judged notion, and has a direct tendency to unremunerating farming. In order to prepare for luxuriant crops, the land, when of a wet nature, must be liberated from all surplus water by proper underdraining; it must be clean from couch-grass and all other kinds of rubbish; not tired out by cross or improper cropping; must be judiciously manured, but not overdone with it, inasmuch as too much manure causes the growth of an unnaturally large quantity of straw, which, if the season happens to be wet or stormy, will be crippled and flat on the ground before the ears could come to perfection. When this happens, it both lessens the quantity and very much deteriorates the quality of the grain. The land being otherwise well prepared, it is perhaps upon the whole more desirable to have a little deficiency of manure than too much, as, if necessary, a partial top-dressing may always be added in the spring. The land must not be wheated oftener than the soil will admit. Some soils will bear it more frequently than others; and it is essentially necessary that the kind of seed should be adapted to the description of soil upon which it is to be propagated. An entire change of seed from hot land to cold, and from cold land to hot, will always be found advantageous, and especially from hot to cold soils, in which case it will frequently bring the harvest nearly a week earlier. In both cases, it is generally allowed to increase the yield, improve the sample, and preserve the stock in greater purity. It has now become very general to sow wheat after clover upon all classes of soils. This is doubtless one of the best systems of growing wheat. The roots of clover after becoming decomposed afford much nutriment to the growing wheat; and the firmness given to the land is another great recommendation. It has been frequently observed when the plant of clover has been deficient that the wheat-plant fails also. This, however, is not always the case: at the same time it serves to show a peculiar adaptation, on many soils, to the growth of wheat after clover.

"There are several other methods of preparing land, varying according to the nature of soils, which oftentimes produce crops of the first order. Some of these are as follows:—First, upon clayey soils, a full summer's fallow is occasionally resorted to as a preparation for the wheat-crop on much of the land in Essex, Hertfordshire, Bedfordshire, and other counties, particularly when the land becomes foul with couch-grass, &c., and cannot very well be brought into a thorough clean state of cultivation by partial fallows, connected with the growth of green crops. Considerable benefit is also derived from summer fallowing upon this kind of soil, as it causes a more perfect decomposition of its constituent parts. This latter effect has been proved in many cases, by experienced farmers, and has come under the observation of the writer. For instance, when

this kind of land has been repeatedly dunged, better crops have frequently been obtained after a full summer's fallow without dung, than after a good dressing of dung without a full summer's fallow. In some parts of the midland counties, upon the heavy soils, where a summer's fallow is the preparation for wheat, about July or the beginning of August, when the soil has been thoroughly cleaned and pulverized, it is formed into two bout stitches 1 yard wide, and manured in precisely the same way as for turnips, putting on from 8 to 10 cart-loads per acre: others spread the dung on the surface and plough it in, forming their land into stitches from 2 to 8 yards wide. In both cases, the land should remain untouched from this period till the time of sowing. In the latter case, the seed is drilled in rows from 6 to 10 inches asunder. When labour is plentiful, the dibbling process is often adopted, and then a less quantity of seed is sufficient. The horse-hoe is sometimes used to cut up the annual weeds immediately previous to sowing, which frequently grow very strong, and would be too much for the harrows to eradicate. When the former plan is adopted—namely, that of ploughing the land into two bout stitches—the plough is sufficient, and there is no necessity for the horse-hoe. The seed is sown under the furrow in the 'spraining' method; one seedsman to two ploughs, which merely reverse the ridges that were made when the land was dunged. Small light seed ploughs are kept for the purpose, which leave a narrow furrow. Many farmers object to this method because of the numerous furrows; but this is an erroneous idea,—for when wheat is drilled or dibbled, the space between each row is often more than the width of one of these furrows. Others object to it because the wheat comes up similar to the broadcast system, and they cannot very well hoe it in the spring; but this is no valid objection,—for if a fallow has been properly managed, the wheat will scarcely require hoeing, since, by continually moving the land during the early part of the summer, most of the seeds of annual weeds have been brought sufficiently near the surface for germinating; and the land being left quiet from the end of July until seed-time gives every encouragement for the weeds to grow; there are consequently but few seeds near enough to the surface for vegetating in the spring. Three men, with two ploughs and four horses, can put in by this system about 5 acres per day. Last year, upon an extensive farm known to the writer, more than half the wheat was sown in this way, and proved remarkably fine, even more so than that sown after clover. In some parts of Scotland, the wheat is sown with a drill-plough, which drills the seed, and covers it in with the furrow turned by the plough: the crop, of course, comes up in drills, and this method is considered to prevent the wheat losing plant on wet and loose soils. It is well known that wheat should be sown when the land is 'clung,' and it is considered better to wait and have a late season of sowing than to put it in when the soil is in a dusty state; which, upon some land, causes the wheat to become root-fallen, and upon soils of a closer texture, where this does not occur, the wheat seldom flourishes so well as when put in after rain. The land is never too wet for sowing wheat, provided it works at all kindly, and the seed can be effectually covered. There are, however, some soils of a peculiar mixture of sand and clay, which, if stirred when very wet, will run together, and afterwards in dry weather form a hard crust, which of course checks the growth of the plant. The best period for sowing wheat on cold clayey soils is from the last week in September to the middle of October, as it seldom becomes winter-proud upon such land. Many think that water-furrowing may be entirely dispensed with where the land has been thoroughly under-drained; but this opinion is not borne out upon very heavy tenacious clays. I have observed that upon such soils the surface-water has not gone off sufficiently quick without it.

"When this or any other kind of land has been previously got into a high state of cultivation, it is frequently cleaned and made ready in the autumn for dunging in the spring, and then sown with turnips or mangold, which are usually carried off in the autumn and the land sown with wheat. But sometimes the roots cannot be removed till late in the season; the time of sowing is then sometimes delayed till January or February, when spring-wheat is generally sown. Upon ordinary heavy soils that have a dry subsoil and do not require draining, white turnips, grown upon the fallows and fed off with sheep during the months of October and November, are an excellent preparation for wheat. When this plan is adopted, wheat is generally grown three times in a double four-course system of 8 years, namely—1st year, fallow for turnips; 2d year, wheat; 3rd year, beans or pease; 4th year, wheat: the next round being—5th year, fallow for swedes; 6th year, barley; 7th, clover; 8th, wheat. Upon some soils a heavier and better sample is produced after turnips than by any other preparation. Wheat is often sown after beans. In this case dung should be applied for the beans, which if kept clean will be a good preparation for wheat. This is preferable to dunging immediately for wheat, which often occasions blight; but, by having an intermediate crop of beans, blight is generally prevented, and better crops, both of wheat and beans, are produced. If farm-yard dung cannot be obtained for the beans, rape-cake drilled in at the time of sowing the wheat, at the rate of from 8 to 16 bushels per acre, will generally be found sufficient to produce a crop. On the heavy clay lands of Norfolk and Suffolk, barley has taken the place of wheat after fallow, and the wheat either follows clover or beans and pease; the rotation commonly adopted being—

1st year, fallow; 2nd, barley; 3rd, half clover, half beans or pease; 4th, wheat. The dung is applied to the pulse by the best farmers, and the crop is well hand or horse hoed. Wheat is drilled after beans, though hand-dibbled by many after clover. Farm-yard manure is used heavily on clover-layers, either on the young seeds during winter, or a short time before ploughing the land for wheat. The former method is preferred by many, because the clover has the benefit of the dung, and the wheat comes 'kindlier.' This system of exposing the manure to the atmosphere will appear to tell against the generally-approved method of ploughing it in: at the same time, admitting that much of its virtue evaporates into the air, yet the clover absorbs a portion of that part of the manure which suits its growth, leaving such properties to be taken up by the wheat which are peculiarly beneficial to it. The system of growing grain-crops on the retentive clayey soils of the eastern counties, is one that might be followed with some advantage on much of our heavy wet land, particularly that which is ploughed in 'high-backed' lands. In travelling through a heavy land district, how often do we see these wide and round lands laid up to an enormous height by repeated ploughings in one direction, under the fallacious idea of draining the land; but how seldom does it answer the intended purpose; though it has this advantage, that the crop in the furrow bears no proportion to that on the ridge. There is also great injury sustained in the cultivation of the land, particularly in the operations of drilling or sowing the wheat-crop; for there is not only the inconvenience, which arises from the rounded form of the land, in carting and tillage, but there is also a very great amount of injury from the treading of retentive land. This is in a great measure prevented by the system of clay-farming more particularly adopted in the eastern counties, Norfolk and Suffolk, which are the acknowledged seat of the origin of drill-husbandry. In those counties we see the width of lands or 'stitches,' as they are termed, adapted to the size of the drill, either for one stroke or for a bout of the machine; and the horses, in drilling, harrowing, rolling, and other tillage operations, invariably walk in the furrows without trampling the soil.

"Upon most of the light chalky or gravelly soils, wheat generally succeeds clover or trefoil; but in cases where the plant of clover fails, early pease are occasionally substituted; and as soon as the pease are removed, the land is sown with either cole-seed, white mustard, or tares, which are fed off with sheep, as a preparation for wheat, and generally succeeds perfectly well. The clover or trefoil is ploughed flat and shallow, the land rolled with a heavy roller. The grooved drill-roller and Crosskill's clod-crusher are both excellent implements for this purpose, though the drill-roller can be used when the land is too moist for the clod-crusher to make effective work, and it raises a greater quantity of mould for the drill. Rolling after the seed is sown, treading or folding with sheep, are means adopted for the purpose of consolidating the soil, and by that means preventing the plant being thrown out, and also for stopping the ravages of the wire-worm. The process of claying light sandy or gravelly soils is essential for the production of a good crop of wheat; it supplies materials that are wanting in the soil, improves its mechanical texture by making it more adhesive and less liable to be acted upon by continued drought. It is commonly found that a greater quantity of seed per acre is used on the light soils than on any other kind of soil. The end of October is considered the best time of sowing.

"Upon rich, deep, dry, loamy soils, wheat is successfully cultivated after potatoes, the potatoes being removed at the latest in October. It is no uncommon thing on some tracts of land—such as are extensively found in the neighbourhood of East Ham, Barking, Romford, Edmonton, Enfield, and other places—to grow wheat and potatoes alternately for many years together. But in order to carry on this system successfully, dung must be liberally used for the potatoes; no dressing beyond this is required for the wheat; the potatoes yielding from 300 to 500 bushels per acre, and the wheat from 30 to 40 bushels. Of course, as above hinted, to carry on this kind of farming, manure must be made rich and applied abundantly, or be obtained plentifully from large towns. Upon this description of land, 4 pecks of seed are amply sufficient; and it should never be sown till the end of October or the beginning of November; if at all earlier, it becomes winter-proud and produces too much straw. I have witnessed the large yield of full 50 bushels per acre throughout a field of 37 acres in the parish of East Ham, in Essex, where the seed was not sown till the middle of December, after a full crop of potatoes. Upon other strong yet rich loams, containing a larger proportion of clay, wheat and beans are successfully cultivated alternately. The beans, being kept perfectly clean, frequently supersede the labour of ploughing for wheat; in which case the land is harrowed previously to drilling or dibbling the wheat.

"Peat-soils are of so loose a texture that they require to be rendered as solid as possible by a good drainage—for peat holds water like a sponge, and when the water is carried off it contracts in a similar manner—by the admixture of clay or other inorganic substances, and by rolling and pressing before and after planting, to insure a medium quality of grain. As these improvements go on in the fens of Lincolnshire, Cambridgeshire, &c., &c. the quality of grain brought to market approaches nearer to that grown on sandy and loamy soils, while the quantity greatly exceeds the corn grown on light sands or gravels. The fen-farmers have one advantage with respect to the growth of a good

quality of grain, which is the absence of hedges and hedge-row trees. A preparation which appears adapted for peat-soils is to plough the land shallow, drill-roll, and hand-dibble the seed in the grooves formed by the roller, and then cover the seed with the harrow. The solidity given to the soil by this method is what is absolutely necessary on the spongy peat-soils. The rolling, and treading, and depth at which the seed is deposited prevent the plants being thrown out by alternate frosts and thaws; and, giving the root a good hold of the soil, in some measure prevent also the crops being lodged or becoming root-fallen. With respect to dibbling, we may observe, that it is acknowledged to be the means of obtaining a stiffer straw; and hence the propriety of hand-dibbling at a cost of 7s. or 8s. per acre on a loose peat.—On freshly broken-up grass-land, oats are preferred to wheat; though, after the surplus vegetable matter of the soil has been reduced by burning, tillage, and the mechanical application of suitable earthy matter, wheat can be grown of good quality. Of course these remarks on fresh broken-up land are general, though not applicable to every case.—It is an acknowledged fact, applicable to every description of soil, that the land prepared for wheat cannot be too stale or solid, provided it be free from weeds, and the surface sufficiently mouldy to cover the seed.

"If a sufficiency of farm-yard manure could be obtained, there would be little necessity for any other, inasmuch as it contains all the ingredients requisite for producing every kind of crop. But let it be understood that the dung should be composed of the excrements of animals well fed under cover. It has been before observed, that when dung is to be applied in liberal quantities for the benefit of wheat, it should, if practicable, be put on the land previous to sowing a preceding root or pulse crop; for thus those ingredients of the dung, which only tend in their first effect upon the land to force an over-abundant growth of straw, will have been extracted, leaving the land in a good state for wheat. Where root or pulse crops are not grown, the dung should be applied to naked fallows for wheat as early in the summer as possible. Though the practice of manuring immediately before sowing the wheat is objectionable, it is still adhered to in many parts of the country. A compost of earth and dung is highly beneficial on light chalky and silicious soils. Four or five loads per acre of farm-yard manure and half a folding with sheep are a good manure for wheat, and frequently adopted by the farmers of the midland counties. A very large proportion of land is manured for wheat by means of the sheep-fold alone, especially upon dry soils, where great benefit is derived by its solidifying the ground; it has also a tendency to kill the slugs and other destructive insects, or at least to put a stop to their ravages. Folding upon fallows is likewise adopted with advantage; upon loose light soils, folding after the wheat is sown is of advantage. Some farmers adopt the plan of ploughing green crops in; but others consider it a better plan to convert all green crops into animal manures, by feeding off with sheep or by soiling. Pigeons' and hen-house dung are frequently used as a top-dressing for wheat, and are almost sure to be beneficial on any soil. From 30 to 40 bushels are used per acre. Like all other light manures, it is best covered by means of harrowing or hoeing, or it may be drilled between the rows. Soot is much used as a top-dressing for wheat, and is commonly found very beneficial. From 40 to 60 bushels per acre are generally applied. It has a tendency to increase the quantity and improve the quality of the wheat, without forcing an undue quantity of straw. It should be sown in February or March at the latest. It is however frequently sown as late as the month of May; but if a dry summer follows, it is in that case of little or no value. As ammonia is the principal ingredient of this manure, it should be covered by means of the hoe or harrow, being liable to waste by evaporation; and, as it is a very light substance, calm and showery weather must be chosen for applying it. This manure is found to be peculiarly suited to the county of Hertford, and consequently a very large proportion of the soot made in the metropolis comes into this county. It has been used in Essex, Kent, Middlesex, and other counties, but in most cases without general beneficial results. Rape-cake is a valuable manure for wheat. It may be applied at the time of sowing the seed, or drilled between the rows in the spring. From 8 to 16 bushels per acre are generally found sufficient. It is best adapted to ordinary heavy soils that are well drained, or have a dry subsoil. Malt-dust, to the extent of from 30 to 50 bushels per acre, is occasionally used as a top-dressing for wheat. Bones may be applied with much advantage upon dry soils previous to sowing the wheat, at the rate of from 16 to 30 bushels per acre. Guano, at the rate of from 2 to 3 cwt. per acre, is sometimes advantageously used at the time of sowing the wheat. This manure is found most beneficial on poor loamy soils. The nitrates of soda or of potash are occasionally used at the rate of from 1 to 3 cwt. per acre, and applied broadcast in March or April. Chemical analysis has proved that wheat always contains a much larger proportion of potash than of soda; hence we may suppose that nitrate of potash is the best of the two: it is, however, the most expensive. As to the application of nitrate of soda to wheat when it has a yellow or sickly appearance in the spring, if finely pulverized, and sown in moist weather, it will in a few days alter the sickly hue to a luxuriant green. As it increases the quantity of straw, it is best suited to poor loams and gravelly soils. Common salt is sometimes applied before sowing the seed, at the rate of from 10 to 21 bushels per

acre, and is often beneficial in bringing the ears to perfection: it also causes a greater weight of grain, but seldom increases the quantity of straw. These are the principal manures that have been proved to be useful for wheat. There are many others; but even a bare enumeration would occupy too much space.

"More wheat is now produced per acre, by greater attention being paid in choosing the most prolific kinds. It should, however, be borne in mind that the most prolific are also very frequently of a coarse quality, and commonly lose in price what they gain in quantity. At the same time it is admitted by those who have put the question to a test, that the most productive are often the most advantageous to the grower. Instances, indeed, have occasionally occurred where heavy white wheat of the finest quality has been tried by the side of a coarser description, and has equalled it in quantity; but this must be considered an exception to the rule, and not the rule itself. On rich soils, where an abundance of straw is produced, short and stiff-strawed wheat yields the best crop, as the weak and long-strawed wheat is liable to be spoiled by being laid. Such varieties as Spalding's prolific and Piper's thickset are suitable for rich land. On very productive wheat-land in Norfolk, Piper's thickset produced such abundant crops, that on its introduction into that county it at once obtained the name of Protection wheat. On the contrary, short-strawed wheats like Piper's thickset are very inferior to long strawed wheat on land that yields a light crop. Mixed wheat (red and white) is sown in some parts of the country, care being taken to select two sorts that ripen at the same time. The advantages to be derived from a change of seed from a hot to a cold soil, and *vice versa*, have already been mentioned. Plants removed from one climate to another will in some measure continue in the same habit of growth. Thus seed brought from a warm country will produce an early crop, though it will be inferior in hardihood to plants grown from seed brought from a cold climate; and it will be found, that, whilst the latter improves by cultivation, the former deteriorates." See the articles Fallow, Rotation of Crops, and Manure.

The Sowing of Wheat.—The great amount of waste which usually occurs in the sown seeds of wheat, as well as in those of other grains, is noticed in the article Agricultural Seeds; the steeping of seed-wheat as a preventive of disease is noticed in the article Smut; the doctoring of seed-wheat, as well as the seeds of other farm crops, with the view of promoting fertility, is noticed in the article Seed; the comparative advantages of the thick and the thin sowing of seed-wheat, together with the proper conditions and covering of the soil in the deposition of the seed, are noticed in the article Sowing; the comparative advantages of the broadcast and the drill methods of sowing are noticed in the article Drill-Husbandry; and the process and properties of the dibble-sowing of wheat are noticed in the article Dibbling.

Wheat seed possesses in a very high degree the extraordinary faculty of being able to re-germinate after having been desiccated subsequently to its first germination. A specimen of wheat which had germinated was subjected by Saussure to a very powerful desiccation aided by the most energetic means which chemistry could supply, and at a temperature of even 158° Fahrenheit; yet it germinated again, even after an interval of several months. Wheat is also capable of resisting several successive alternations of desiccation and germination. If, in its first germination, the radicles have made a certain progress, no further development takes place in the second germination, but other radicles are formed. This valuable property of wheat accounts for the circumstance of its remaining several months in the ground, in dry seasons, before making its appearance; and the surprising vitality which it evinces has been exemplified in the wonderful fact that some wheat seed found among the cerements of Egyptian mummies, and therefore far upwards of two thousand years old, has germinated on being committed to the soil. A wise farmer, however, will not trust too much to the mere vigorous vitality of any seed-wheat for his crops, but will use all care that every specimen be perfectly sound and fresh, and will look only to the first germination of wheat-plants as likely to portend a productive and seasonable ripening.

Seed wheat ought always to be of the best quality which can be obtained; and, where choice is limited, a perfectly sound and fresh specimen of a second-rate variety ought to be preferred to a damaged or doubtful specimen of a first-rate one. A seemingly prime specimen, indeed, will sometimes produce an inferior crop, while a seemingly poor specimen will produce a good crop; but such a result must be ascribed to soil and season or other favourable circumstances, and may be supposed to arise in defiance of the peculiar condition of the seed; for just, as all other things being equal, the best sample of grain will produce the best flour, so the best specimen of seed-corn will produce the best crop. And in fact the well known rules for judging the comparative value of wheat grain for the miller apply very closely to the judging of its fitness for the sower. "It should be retained a minute or two in the closed hand, and then passed gently through it, to ascertain if the grain be plump, hard, dry, and smooth, with a certain sense of mellow fulness in the feel; for, if it handles rough, and does not slip readily through the fingers, it will be found thick skinned, damp, and unprofitable to the miller. Of whatever species it may be, it should also be carefully examined, to see that it be of a bright and healthy appearance, the grains of nearly equal size, and unmixed with the seeds of weeds and smutty or sprouted

corn. The smell should likewise be noted; for the least taint of its sweetness is a sure sign of its having been either damp or heated. The weight can be guessed within a pound or two in the bushel, by being poised in the hand by any one accustomed to examine samples; but accuracy of judgment can only be attained by long experience. The quality of any one species can thus be correctly estimated by any one who is in the habit of attending a corn-market; but large quantities are imported from abroad, and also made up for sale by the dealers of this country in a mixed state. The white wheat from the Baltic is generally mixed with red wheat, and is known in our markets under the denomination of 'good,' and 'fine-high mixed,' 'red-mixed,' and some more ordinary qualities,—the first weighing from 61 to 64 lbs.,—and the latter from 56 to 58 lbs. per bushel, running in the proportions of one-third white to two-thirds red; and the price varying from 10s. to 15s. per quarter less than the superior articles, in proportion to the quantity of red. This mixture, however, although not rejected by the millers—who frequently find the use of a portion of it indispensably necessary to the grinding of the new corn—yet renders it unfit for the use of the farmer as seed; for the different qualities could neither be advantageously grown on the same land, nor would they ripen at the same time. The wheat which is shipped in large quantities from Odessa, on the Black Sea, and which in scarce years sometimes finds its way to this country, it would be also dangerous to use as seed, for the length of the voyage generally occasions it to become heated." [British Husbandry.]

The proper quantity of seed will in a degree be determined by each farmer's theory of the comparative advantages of thick and thin sowing; but, irrespective of this, is powerfully controlled by the nature of the variety, the time of sowing, the nature of the soil, the stage of the rotation, the amount of apprehended accidents, the manner of sowing, whether broadcast, drilled, or dibbled, and a number of other considerations. Any spring wheat tillers worse than a corresponding kind of winter wheat, and, on that account, requires from one-half to three-fourths of a bushel more of seed per acre; and any kind of winter wheat when sown early requires less seed than when sown late,—and, when sown after summer fallow, requires less than when sown after potatoes,—and when sown after potatoes, requires less than when sown upon newly broken up grass land. "The nature and condition of the soil," remarks Mr. Roberts, "the variety of wheat, and the quantity of vermin that consume the grain before or after it vegetates,—all have some effect on the quantity of seed required. The poorer the land, the more plentiful must be the seed. On a poor gravelly soil, where an abundance of manure is not attainable, 10 pecks are requisite, drilled at from 6 to 8 inches; and we find, from observation of both wet and dry seasons, that when this quantity is at all sensibly decreased, or the intervals between the drills increased to a material extent, the crops suffer a diminution both in quantity and quality. When the land is good, very little seed is required, for it always branches out in the spring; but on poor land, when sown late, many of the plants die, at the same time that others on good land are preparing for numerous branches. Nothing definite, therefore, can be named as to the proper quantity to be sown. Upon the broadcast system, where 2½ bushels per acre are sown, it is generally allowed that, if drilled, 2 bushels would be equivalent, and if dibbled 5 pecks. As an instance of the effect of time I may mention that upon a poor heavy soil, if we commence in September with 2 bushels, by the middle of October we increase it to 2½ bushels per acre. It has been repeatedly proved that upon land of the best quality, and in high cultivation, if dibbled and put in perfectly regular, 4 pecks of seed per acre are better than more, inasmuch as it leaves a roomy and healthy space between the plants, encourages branching, and produces stiffer straw, with plumper ears, than when sown thicker, and upon the whole gives the most certain and fullest production that the land is capable of. Thickly-sown wheat on rich land grows much weaker straw, smaller ears, and is liable to fall down long before the usual time for coming to perfection. We have heard of transplanting wheat, and I can assign no good reason why it should not be more generally adopted. It is true it would be a somewhat tedious operation to plant many acres in this way; but when it is considered what a small portion of seed would be required, it might repay the farmer for his trouble and expenditure."

The time of sowing wheat is controlled by the state of the weather, the stage of the rotation, the quality of the soil, the character of the climate, and the nature and adaptations of the varieties of the plant. After summer fallow, in favourable weather and on suitable soils, winter wheat may be sown in Scotland as early as the beginning of September, and in the centre and south of England as early as the 20th of September; and either in the event of unfavourable weather after summer fallow, or in other circumstances of rotation and soil, it may be sown in Scotland at any time till the middle of November, and in the centre and south of England at any time till the last week of November. On very strong clays or cold soils, the sowing ought to be at the very earliest eligible period, and ought not if possible to be delayed later than about the middle of October in Scotland, or the end of that month in the centre and south of England; for such soils, when thoroughly drenched with moisture in autumn, are seldom in a proper state for harrowing till spring,—and wheat sown upon them in good condition in September, will take

a firm and deep hold of the ground before frost commences, and will escape all danger of becoming 'winter-proud,' and will be less liable to mildew, and ripen about a fortnight or so earlier, and afford correspondingly greater advantages of harvesting, than if they were sown four or five weeks later. On warmer soils, particularly good dry gravelly loams, in hearty and well-prepared condition after clover, the sowing ought not to be earlier in Scotland than about the middle of October, or in the centre and south of England than about the end of that month, and, if weather and other circumstances permit, may prove most successful in the second week of November in Scotland, and in the last week of November in the centre and south of England; for if the sowing on such soils be earlier than the former of these periods, the plants get too forward, and do not mat on the ground, and become weak, and spindle into long slender stems, and frequently lose their healthy appearance in spring. On the best kinds of these soils, indeed, the sowing of winter wheat, even in Scotland, may sometimes be advantageously done in spring; and on all of them, in some of the central and southern parts of England, this date of sowing has come to be systematically preferred by a few intelligent agriculturists to autumn or winter sowing. "So satisfied have I been for several years past," said Mr. George Webb Hall in 1842, "of the advantage of taking the spring for depositing wheat in the earth, upon certain soils and regulations, that on such I have abandoned autumn sowing entirely. The soils and situations to which I refer are—the silicious soils, the turnip and barley soils of agriculture, and, in fact, including all the land of our country which is not comprehended under the description of clay or very tenacious loam. It will be prudent to limit so extensive a range by two other principles—first, climate, varying as it does with aspect; and secondly, the condition of the land with regard to fertility, and the result of manure and good tillage, fitting it to bear a crop of wheat at all. Under these limitations, and they are not very exclusive, I am prepared to recommend the spring sowing of winter wheat in any season over a considerable portion of such land. The period of sowing is generally the last week of February or the first week in March, and the interval until harvest is about 25 weeks, as the season may be forward or otherwise. The produce in this time has been 40 bushels per acre, upon a light sandy loam, but in condition certainly for its duty. The sort has been generally the white Lammas or Taunton white; but it has not been limited to that sort; Essex white wheat has been sown with equal success, and similar progress as to time. The elevation at which it has been sown has not been limited; for I sowed it last year about 400 feet above the level of the sea; and a friend of mine, a highly respected and veteran improver of agriculture, George Tollett, Esq., of Beatley Hall, Staffordshire, tried it to his complete satisfaction in the unpropitious year, 1839. The chief cautions I would recommend are—first, selection of seed from good conditioned land, and a warm soil and situation; secondly, rather thick sowing, as a security for adequate plant and prevention of mildew, by obviating predisposition to it." The sowing of spring wheat after eaten-off turnips in Scotland, may be done at any time between the first of February and the middle of March, and has occasionally been done with tolerable success so late as the first or second week of April, but, when done after the second week of March, entails a risk of imperfect ripening and precarious harvesting; and the sowing of spring wheat in the centre and south of England may occasionally be done as early as in Scotland or so late as the beginning of May; but is generally most successful about the middle of April, in consequence of its then combining the advantages of escaping liability to white frosts and ensuring the greatest probability of gentle showers for the promotion of vegetation.

The operation of sowing wheat is so well understood by almost all farmers, and has been so fully explained, in its several accompaniments and methods, in the articles Sowing, Sowing-Machines, Broadcast Sowing, Drill-Husbandry and Dibbling, and in some parts of the preceding section of the present article, that nothing requires to be said here respecting it. The depth at which the seed is deposited in the broadcast method and in some of the ordinary practices of the drill method, varies in every part of the same field from less than one-fourth of an inch to upwards of two inches; and if we consider how very vigorously shaken wheat vegetates in the following year among sown grasses in spite of its being not at all covered by the soil, this variableness in the depth of the deposition might seem to be very little injurious, and really is far less so than most views of the case would lead us to suppose; yet, in every instance, a variable depth is apt to produce a variable vigour, or less depth than about two inches does not afford sufficient protection from the long beaks of rooks, and any depth which might be quite great enough on heavy wet clays may be much too small for friable loams, and especially for very light porous soils. A uniform depth in every case is desirable; and where 2¼ or 2½ inches would be suitable for stiff clays, 4 inches might be required by dry and porous loams. "For security against a severe winter," says Mr. Hillyard, "wheat seed should be deeply drilled in. Frost cannot kill the blades of wheat, if the roots are secured under a good covering of mould. There were great complaints in the spring of 1838, that a great portion of the wheat crops were at that time very thin of plant, and that many fields had been ploughed up. Mine were

never finer; and I feel satisfied that had other persons' seed been drilled in 4 inches deep like mine, there would not have been such complaints of loss of plant. I, then, could show proof for my assertion. In one of the bouts of the drill, in consequence of seed enough not being put into the machine, for 40 yards no seed had been deposited. On this being discovered, drills were made with a hand-hoe, and corn put in. This, which was put in about 2 inches deep, came up much sooner than the other put in 4 inches deep, and looked best till Christmas; but, from the frost getting to the roots of it during the severe weather we then had, every root went off in the spring."

The consolidating of porous soils immediately after sowing them with wheat is highly advantageous, both for giving the plantlets a firm root-hold and for preventing or diminishing the devastations of the wire-worm. "On light soils, in my opinion," says Mr. Hillyard, "there is no way so good for putting in seed wheat as with the presser; and as it is not possible to make such soils too solid for wheat, it would be well, should the weather be favourable, to roll after the seeding, and afterwards drive a flock of sheep several times over the land. It has often been said that growing wheat is not injured by a field of fox-hunters riding over it, and even produces more grain in consequence. On light soils it does not do the injury that might be expected from appearance, but on strong land it does great harm, for in all the holes formed by the horses' feet, and particularly if going down hill, water will stand, and the plants in these holes will die. But immediately after sowing, the trampling of horses does good. A late friend of mine in the Blues, who occupied a farm of light soil near Windsor, found it to be a great benefit to his wheat crops to have his troop walked up and down them, not galloped, immediately after sowing."

The After-Culture of Wheat.—A very thin or very sickly crop of autumn-sown or winter-sown wheat should not be too hastily broken up in spring; for after a few days of warm weather, it may suddenly revive, and may acquire vast increase of strength and fulness from luxuriant tillering; or, if it exhibit breaks and patches, it may be facilely and completely mended by inter-dibblings of some variety of spring wheat which may ripen nearly at the same time as the main crop, and may furnish a closely similar sample of grain. The after-culture of all tolerably healthy crops is directed mainly to the prevention of out-throwing by frost, of devastation by the wire-worm, of impoverishment by weeds, and of lodging and running to straw from excessive luxuriance; and it requires to be much more assiduous after a preparatory crop than after a summer fallow, and very much more so on any kind of loose or light soil than on a firm and cohesive one; and, in all its chief features, it is well described in the following succinct terms by Mr. Roberts:—"Pressing in the spring during dry weather, and before the wheat becomes too forward, is generally productive of good, though especially required on soils that are naturally loose and light in their texture, and on those soils which require draining; for where water saturates the surface soil, it becomes increased in bulk during winter by its conversion into ice in frost, which, of course, raises the soil, and when the frost goes away the plants are partially thrown out. This is accounted for thus:—The frost causes the ground to swell, and, as it rises, the root of course rises with it; when it thaws, the ground shrinks, but the root remains in its elevated position, and, by the action of alternate frosts and thaws, is at last thrown entirely aboveground. This must occur to the greatest extent on soils containing superfluous moisture, though it will occur on any soil, particularly those of a calcareous nature, when frost happens to follow immediately after rain. Therefore, when the soil treads loose in the spring, it is very important to use the heavy roller, or some other means of consolidating the soil. Crosskill's clod-crusher is highly beneficial for this purpose, but can only be used in very dry weather. Treading with sheep is also an effectual way of fastening the roots. On the loose soil of the fens the wheat is trodden by gangs of men and women, each treading along one drill; by this means the soil is consolidated effectually: it is not an expensive operation, and on the loose vegetable soil of the fens is more efficacious than rolling. The feeding off wheat with sheep in the early part of the spring, when likely to run to too much straw, is useful on rich soils. If the land be foul when the seed has been sown broadcast, it must be cleaned by hand-hoeing; but, if drilled or dibbled, the horse-hoe may be successfully used. In many places the practice is to hoe wheat, whether foul or not. As a general rule, hoeing should be begun as early in the spring as the weather permits. Harrowing is occasionally found beneficial, particularly when the ground is crusty and the root lies deep in the ground: it has the effect of loosening the surface, and, whether that be done by the hoe or harrow, an improvement will be seen in a few days by the fresh vigour of the plants. Harrowing light sands and gravelly soils obliquely across, or at right angles to the drills, is peculiarly advantageous, as it destroys the red-weed or poppy and other annuals that infest light land. For the destruction of the poppy it is recommended to harrow when the soil is slightly crusted with frost. When, from the extreme luxuriance of the crop in the spring, there appears a probability of its being laid, the process of flagging is resorted to as a preventive. Flagging is executed by means of the bagging-hook or scythe, separating the flag or blade from the stalk. This should be done about May, before the formation

of the ear; and in doing it the stalks will require examination, that the ears may not be cut off." Harrowing, however, ought to be done with caution, whether upon stiff hidebound soils for fear of predisposing the crop to mildew and tearing up the roots of the plants, or upon light and porous soils for fear of rendering them too open and of lacerating the crop; and it should be performed in every case with a due adaptation of the weight and action of the harrow to the amount of effect intended to be produced; and, whenever the cultivation of the wheat crop is combined with the raising of clover and grass seeds, most or all of the spring-culture of the young wheat must serve at the same time for the sowing of the grasses.

Wheat is an excellent nurse to a crop of clover and ryegrass, for its foliage is small and of comparatively short duration, and falls down almost as soon as it has attained full size, leaving the infant clover and ryegrass ample aeration to assist their growth. Spring wheat is often used for this purpose in England; and autumn or winter sown wheat is suitable for it in both England and Scotland. When spring wheat is used, the grass-seeds are sown simultaneously with it in the same way as with barley; and when winter wheat is used, the grass seeds are sown among the young wheat plants as early as convenient in April. The clover and grass seeds, preparatorily to their being sown, are mixed carefully together, and brought to the ground in sacks; the wheat-land, if open and clean on the surface, requires no preparation for them, but if foul or hidebound, may be scratched with either the harrows, the horse-hoe, or the hand-hoe, according as it is broadcast sown or drilled, or as it needs much action or little; the grass seeds may be sown either by hand or with the broadcast sowing-machine; and if the surface be loose, a rolling alone may be given to cover them in,—or if the surface be crusty and hard, or in any of the conditions which require decided after-culture for the wheat, either a double turn of the harrows may be given along the ridges and a turn of the roller across them, or any other amount of similar operations may be performed to suit the peculiar circumstances of the crop and the soil; and after these operations have been done, no further culture can be given to the wheat except to hand-pull any large weeds which may appear during the progress of its growth.

Excessive luxuriance of autumn sown wheat crops in spring, arising from unusual forwardness of vegetation during winter, and popularly designated by farmers 'winter-proud,' is a greater evil and requires nicer management than the brief remarks of Mr. Roberts upon it, in the passage quoted in a previous paragraph, might lead one to suppose; and in particular, it occasions a premature exhaustion of the vigour of the plants, causes them to mount speedily up into a great mass of straw, and divests them of power to produce a fair proportion of grain. "From the greater height to which the straw thus rises, and as well the weakness of its stems, the crop is also more in danger of being lodged by storms, and is found to be generally more liable to mildew. It is, therefore, in such cases, very commonly eaten down by sheep; or, by some farmers, it is occasionally, though very rarely, mown. The progress of vegetation is thus checked, and the apparent danger is avoided; but it requires great circumspection and practical experience to ascertain when it may be proper to adopt it; for although the temperature of the season may have pushed the plants too forward, yet a change may immediately take place, and their having been thus weakened, will throw them too much back. If the plants tiller with such strength as to grow in thick tufts which cross each other or that they appear likely to become lodged, then it may be safely adopted; otherwise, it is better to leave the crop to its chance, without meddling with it, and in no case should it be attempted unless the vegetation be extremely rank. The practice of feeding, though by far the most general, has yet been objected to, because the sheep prefer the tender blade in the heart of the plant, which ought to be preserved, and reject the coarse blades which ought to be taken off; but if adopted, such a number should be put upon the ground at once, as will eat the wheat down to the required distance promptly, and when removed, they should not be again returned to the land. If mown, the work should be very carefully performed, at such a distance from the surface of the land as not to touch the heart of the plants."

The Harvesting of Wheat.—The ripening of the grain of wheat must not be judged by the ripening or mellowing of the straw. In some circumstances, the root and the ear seem ripe, while most of the straw is still greenish or succulent; and in others, the straw, from the root upwards, loses its succulency, turns yellow, and gives the whole plant the appearance of ripeness, while the grain in the ear is still soft or almost pulpy; and only in cases of entire and uniform healthiness in the crop, and of steadiness and general favourableness in the season do all the parts of the plant arrive with perfect simultaneousness toward maturity. Some farmers contend that a crop which has become dead at the root while it still continues soft or pulpy in the grain, should be allowed to stand for some time enjoying the effects of air and sunshine before it be cut down; and others regard it as so completely defunct from all possibility of further nourishment or benefit that it ought not to stand another day; and both may be either right or wrong,—that is, right in one year and wrong in another,—according to the nature of the weather. All wheat, except such as is grown mainly or largely for sake of its straw, ought to be judged as to readiness for reaping solely by the grain; and this is always in a state of the highest fitness for the

purposes of the miller and the baker, and therefore in a state of truest ripeness, when in the medium stage between softness and solidity which farmers technically call "raw." If the grain be quite pulpy or too green, it shrivels in drying, and suffers loss in both quantity and quality; and if it be quite solid or too ripe, it exchanges a considerable portion of its nutritious principles for innutritious ones, and is also liable to be shaken out by the wind and to shed in reaping. Many rules have been proposed for enabling farmers to decide as to the precise moment when their wheat may be most profitably cut; but some overlook casual and important differences which occur in different crops and seasons, many proceed on false views of the true nature of ripeness, and most are empirical and allow the crops to stand too long uncut; and incomparably the best rule which has ever yet been proposed is to cut wheat when the grain is in the state called "raw," or in medium condition between pulpiness and solidity, or, as nearly as can be conjectured, about 14 days before it would become what is popularly termed ripe. This rule leads to a great saving in the produce above what would result from the ordinary practice, and is therefore of vast consequence to the interests of farmers and of the whole population; and it was worked out and proved, by Mr. Hannam of North Deighton in Yorkshire, in a course of masterly experiments and reasonings, which we must here detail at considerable length and in his own words.

"Having selected a field of old square-headed red wheat for the experiments," says Mr. Hannam, "on August 4, 1840, I cut a sheaf. At this time it was quite green, that is, both straw and ears were in full vigour and full of sap. Though the grain appeared perfectly formed, the chaff still adhered so firmly to it that it was scarcely possible to separate them by friction in the hands. When separated, it was large and plump, but so full of milk that the slightest pressure reduced the whole to a juicy consistency of pulp. This sheaf stood in the field for a fortnight, when it was housed. On the same day, August 18, I cut another. The wheat was of course yet 'green,' speaking positively, or 'not ripe,' if we speak negatively,—being what farmers commonly term 'raw,' that is, the straw, though appearing at a distance green, when examined closely was of a hue fast approximating to yellow, while, for about a foot upwards from the ground, it was quite yellow. The ears, too, were more open, the chaff tinged with various shades of yellow and green, and the grain itself, when separated, soft and pulpy, but not near so full of fluid as before. The judgment of the farmer will, however, best tell him the conditions of the wheat, both at this and the preceding cutting, when I say, that in another fortnight the whole field was ripe. At the end of this fortnight (September 1,) I housed the sheaf cut on August 18, and which had remained exposed to the weather in the interval, and cut a third. This I have said was 'ripe;' but by the term I don't mean that degree of ripeness when the straw breaks, the ears curl, and the grain shakes out, but that condition in which it is customary to commence reaping it,—when the straw, from the roots to the ear, is uniformly yellow, and has lost all symptoms of vivid health. On the 14th of September the third sheaf was taken from the field and carefully preserved, along with the other two, till the 1st of November, when, out of each sheaf, I selected 100 ears, and put each parcel into a separate bag. The straw from each of these parcels of ears was preserved carefully. The ears in one bag (No. 1, or that cut very green) were now thrashed, the chaff carefully separated, and the gross weight of the corn yielded ascertained by an extremely accurate balance. The weights of a fixed measure of a certain number of grains were next found: to avoid error, this was repeated several times. No. 2. (cut raw) and No. 3. (ripe) underwent the same process: for the results of which see the following table.

Comparative Weights of *Wheat* reaped at different periods.

Time of Reaping and Condition.	Gross Produce.	Equal Measure.	Equal Numberof grains.
No. 1. Aug. 4. (very green)	576	568	19¾
No. 2. Aug. 18. (raw) .	736	580	23¼
No. 3. Sept. 1, (ripe) .	650	570	22¾

As this table is merely comparative (the weights used being in parts, and decimal parts of the same, for the convenience of minute experiments,) it may not be unnecessary to give the following table of the absolute weights of each sample in ounces, drams, scruples, and grains Troy:—

	Gross Produce.				Equal Measures.				Equal Number of Grains.			
No.	oz.	dr.	scr.	gr.	oz.	dr.	scr.	gr.	oz.	dr.	scr.	gr.
1.	4	0	0	0	3	7	1	13	0	1	0	5¾
2.	5	0	2	13	4	0	0	13	0	1	0	17½
3.	4	4	0	6	3	7	2	0	0	1	0	15¾

The straw belonging to each sample was now weighed (all the parcels having previously been made of the same length, commencing from the bottom of the ear,) when the following was the result:—

Comparative Weights of 100 *Straws*, of an equal length, belonging to the Samples Nos. 1, 2, 3.

No. 1 (green,) = 550.
No. 2 (raw,) = 475.
No. 3 (ripe,) = 450.

The next thing to be ascertained was the quality of the produce, or the comparative worth of each description. Believing in the old saying, that

> "The proper value of a thing
> Is just as much as it will bring,"

on the 5th of November I attended market and asked the opinion of an extensive corn-grower as to the values of the respective samples, according to the prices of the day. His opinion was,

No. 1, . . . 61s. per quarter.
No. 2, . . . 64s. do.
No. 3, . . . 62s. do.

Putting the same samples into the hands of an extensive corn-factor and miller, his value, and what he would give to buy, was, for

No. 1, . . . 61s. per quarter.
No. 2, . . . 63s. do.
No. 3, . . . 61s. do.

Adding these values respectively together, and taking the mean price of each (by which we shall obtain as near an approximation to the truth as possible,) we have

No. 1, = 61s. 0d. per quarter.
No. 2, = 63s. 6d. do.
No. 3, = 61s. 6d. do.

The loss or gain on these samples, by reaping at different periods, will be best seen from the following

Table of the *Relative Weights* and *Value* of *Wheat* cut August 4, August 18, and September 1; that cut last (or ripe) being taken as the standard, and unity assumed as its value in each column.

No.	Weight of gross produce.	Weight of equal measures.	Weight of an equal number of grains.	Value.	Weight of the straw.
3, Sept. 1, (ripe,)	1	1	1	1	1
2, Aug. (raw,)	$1\frac{43}{325}$	$1\frac{1}{57}$	$1\frac{2}{91}$	$1\frac{4}{123}$	$1\frac{1}{18}$
1, Aug. (green,)	$\frac{288}{325}$	$\frac{284}{285}$	$\frac{70}{91}$	$\frac{122}{123}$	$1\frac{2}{9}$

According to this table, it is evident that the wheat reaped a fortnight before it was ripe has the advantage of the ripe in every point:

1st, In weight of gross produce $\frac{43}{325}$, or $13\frac{1}{5}$ per cent.

2d, Do. equal measures $\frac{1}{57}$, or nearly $\frac{1}{2}$ per cent.

3d, Do. equal number of grains $\frac{2}{91}$, or nearly $2\frac{1}{5}$ per cent.

4th, In quality and value $\frac{4}{123}$, or above $3\frac{1}{4}$ per cent.

5th, In weight of straw $\frac{1}{18}$, or above 5 per cent.

On the other hand that reaped a month before it was ripe, has an advantage of 22 per cent. in weight of straw, compared with the ripe, but in every other point has the disadvantage: Thus,

1st, In weight of gross produce $\frac{37}{325}$, or $11\frac{5}{13}$ per cent.

2d, Do. equal measures $\frac{1}{285}$, or rather more than $\frac{1}{3}$ per cent.

3d, Do. equal number of grains $\frac{2}{91}$, or better than $13\frac{1}{6}$ per cent.

4th, In quality and value $\frac{1}{123}$, rather more than $\frac{4}{5}$ per cent.

It may be here necessary to mention that the sample No. 3 (ripe) was very bold, but rather coarse, feeling rough in the hand; while No. 2 (raw) was quite as bold, but very fine and thin in the skin. No. 3 (green) was also a good and clear sample, but much smaller than either of the other. This will account for the apparently anomalous fact of there being scarcely any difference in the marketable value of the green compared with the 'ripe,' while there is a difference of 13 per cent. in favour of the ripe in weight of equal numbers of grains; for the sample being dry and good, the buyer lost little by this inferiority in the size of grain, as the weights of equal measures were the same,—the difference of $\frac{1}{285}$ scarcely making $\frac{1}{2}$ lb. in the sack.

"Before venturing to draw any deductions from these experiments, let us put their results in a still more practical point of view. Suppose we have three acres of wheat, one of which, reaped when ripe, yields us 30 bushels of corn and one ton of straw; what will be the gross value of the same? And what the value of the other two acres, according to the data furnished by the foregoing experiments, supposing each acre to be exactly equal in crop, and the one reaped a fortnight and the other a month before the ripe? Before answering this, we must fix a value for the straw—say 2d. per stone, which, taking into account that used by the farmer himself—and many cannot sell any—is as much as it is actually worth. Whence we have, for the acre of ripe,

30 bushels of wheat, at 61s. 6d. per quarter (the price of sample No. 3,)	£11	10	$7\frac{1}{2}$
1 ton of straw, at 2d. per stone,	1	6	8
Gross produce,	£12	17	$3\frac{1}{2}$

Let us next take the acre cut 'raw.' Before we can come to its value, we must first resolve the question, How much, in measure, will the acre produce us, supposing it to produce 30 bushels, if cut when ripe? In solving this, as we must assume each crop to be exactly equal if cut at the same time, it is obvious that, if we would determine the difference caused by reaping at an earlier period, we cannot found our calculations upon the gross weight of the two samples (Nos. 2 and 3;) for, although there is no doubt but that this weight was materially affected by the condition of the wheat at the time of reaping (indeed the difference in the weight of equal numbers of grains proves the fact,) it is possible that, in selecting the 100 ears from the sheaf, I might take out of one sheaf ears with a greater number of grains in them than those taken out of the other. This, then, would affect the total or gross weight; and, therefore, it cannot be taken into account in the present case, where both acres are supposed to have an equal number of grains. To the weights of equal measures, and of equal numbers of grains, both the result of many careful trials, this objection cannot be urged; and they are amply sufficient to enable us to tell the produce of an acre of 'raw,' when that of the 'ripe' is 30 bushels. Thus, in the first table, we have

	Weight of equal measures.	Weight of equal numbers of grains.
No. 2 (raw,)	580	23.25
No. 3 (ripe,)	570	22.75

Now put $m =$ this measure, and $n =$ the number of grains weighed of each sort; then

$n : 22.75 :: 1 : \frac{22.75}{n} =$ the weight of one grain of No. 3, whence

$\frac{22.75}{n} : 1 :: 570 : \frac{570\,n}{22.75} =$ the number of grains of No. 3 in the measure m. Again, similarly, $n : 23.25 :: 1 : \frac{23.25}{n}$, weight of one grain of No. 2, and

$\frac{23.25}{n} : 1 :: 580 : \frac{580\,n}{23.25} =$ the number of grains of No. 2 in the measure m. And $m \div \frac{570\,n}{22.75} = \frac{22.75\,m}{570\,n} =$ the space occupied by one grain of No. 3 (ripe); and

$m \div \frac{580\,n}{23.25} = \frac{23.25\,m}{580\,n} =$ the space occupied by one grain of No. 2 (raw.) Now, as there are the same number of grains upon each acre, and as the acre of ripe yields 30 bushels, we have

$\frac{22.75\,m}{570\,n} : \frac{23.25\,m}{580\,n} :: 30$ bushels : 30.1307313 bushels, the produce of one acre cut a fortnight before the ripe. Again, by reference to the second table, we have 1 and $1\frac{1}{18}$ as the relative weights of the straw No. 3 and No. 2; whence as No. 3 is supposed to produce one ton,

$1 : 1\frac{1}{18} :: 160$ stones : $168\frac{8}{9}$ stones, the weight upon the acre reaped when raw. And for the whole produce of the acre, we have

30.1307 bushels of wheat, at 63s. 6d. per quarter,	£11	19	$1\frac{3}{4}$
168 stones of straw at 2d. per stone,	1	8	$1\frac{3}{4}$
	£13	7	$3\frac{1}{2}$

Adopting the same course for the produce of the acre cut first, *i. e.* a month before the ripe, and which corresponds with sample No. 1, we get

$\frac{568\,n}{19.75}$ = the number of grains of the green in the measure m; whence $\frac{19.75\,m}{568\,n}$ = the space occupied by one grain of green.

But (*vide* above,) $\frac{22.75\,m}{570\,n}$ = space by one grain of the ripe; whence $\frac{22.75\,m}{570\,n} : \frac{19\,75}{568\,n} :: 30$ bushels : 26.1356 bushels, the produce of the acre cut a month before the ripe. And (*vide* 'Table of relative weights, &c.)

1 : $1\frac{2}{3}$ :: 160 stones : $195\frac{5}{9}$ stones of straw, the produce of the same; whence we have

26.1356 bushels of wheat, at 61s. per quarter . . .	£9	19	$3\frac{1}{4}$
$195\frac{5}{9}$ stones of straw, at 2d. per stone,	1	12	7
	£11	11	$10\frac{1}{4}$

The total products of the three acres stand thus:

No. 3, Reaped when ripe, . .	£12	17	$3\frac{1}{2}$
No. 2, Do. a fortnight earlier, .	13	7	$3\frac{1}{2}$
No. 1. Do. a month before the ripe,	11	11	$10\frac{1}{4}$

Showing a loss of £1 5s. 5d., or about 10 per cent., by cutting very green; and a gain of 10s. per acre, or nearly 4 per cent., by reaping in a raw state or a fortnight before it was ripe.

"From the above details, it would appear that it is the farmer's interest to cut his wheat before it becomes thoroughly ripe. Many, no doubt, will be disposed to doubt deductions of such importance drawn from such limited experiments. This objection the writer anticipates, because it is a natural one, which he felt himself, when he considered the most important conclusions which resulted. When, however, he retraced, step by step, his investigations, without any variation in that result, he could no longer refuse to believe it true till he proved it untrue. He is aware that there are other points of consideration in this subject—that there are peculiarities in the nature of land, of seed, or of season, and that there is, as in all man's investigations, a possibility of error,—any of which circumstances might materially affect the result of experiments upon so limited a scale as the present one; and for this reason he gave the subject a trial in the ensuing harvest, on a much more comprehensive scale; and not one single operation in that trial, neither reaping, stacking, thrashing, dressing, grinding, nor weighing, was carried on without his immediate superintendence.

"The field of wheat chosen for this experiment was an even average crop, the soil thin limestone, and the seed the old square-headed red,—the same experimented upon before. In order to make the experiment more valuable, and to fix more accurately the golden mean between the too green and the too ripe, I had 20 perches of adjacent furrows reaped at the following periods:—

No. 1,	reaped	August 12th,	stacked	August 26th.
No. 2,	do.	August 19th,	do.	August 31st.
No. 3,	do.	August 26th,	do.	September 5th.
No. 4,	do.	August 30th,	do.	September 9th.
No. 5,	do.	September 9th,	do.	September 16th.

On stacking the various cuttings, I took a sheaf from each parcel, for the purpose of exhibiting a sample of the grain of each at the annual meeting of the Wetherby Agricultural Society, held September 22, 1841. As in my former experiment, the sample of the ripe wheat, No. 5, appeared bold but coarse, while the green, Nos. 1 and 2, were finer in the skin, but smaller in size. The raw cut, No. 3, however, was unexceptionable as a sample; being equal in boldness and fulness of grain to No. 5, and superior to Nos. 1 and 2 in the thinness and uniform clearness of skin. Scarcely any difference was discoverable between 3 and 4; the latter was, however, rather more rough to the touch than the former. This superiority of the raw cut grain was observed and acknowledged by hundreds of practical agriculturists at the meeting alluded to, and was confirmed by the judges, who awarded to me one of the extra premiums, 'with a high commendation of the sample No. 3, reaped a fortnight before the ripe.' On February, 1842, the whole of the various cuttings were thrashed and dressed under my own eye, when the following were the results:—

	Bushels of Wheat.	st.	lbs.		st.	lbs.	
No. 1 gave	$2\frac{3}{4}$ weighing	11	12	and	22	7	of straw.
2 ,,	$2\frac{1}{2}$,,	11	1	,,	21	3	,,
3 ,,	$3\frac{1}{2}$,,	15	10	,,	20	8	,,
4 ,,	$3\frac{11}{16}$,,	16	6	,,	19	2	,,
5 ,,	$3\frac{1}{2}$,,	14	13	,,	18	0	,,

Having in my former trial ascertained the value of the various samples by the opinion of the market, and in this case confirmed it by the public decision of the judges at an agricultural meeting, I determined, in order to leave no loophole for doubt, to test their qualities at the mill, and to see in what, and to what extent, the difference of quality existed. Having, therefore, to prevent mistake, affixed my own seal to the sacks, and placed them under the care of Mr. John Hardcastle of Hunsingore Mills, near Wetherby, the gross quantity of each variety was ground and dressed with the following results:—

	Gross Quantity.	Weight of Grain.		Weight of Flour.		Pollard, or "Sharps."		Bran.		Waste.
No.	Bushels.	st.	lbs.	st.	lbs.	st.	lbs.	st.	lbs.	
1.	$2\frac{3}{4}$	11	12	8	12		12	2	1	1
2.	$2\frac{1}{2}$	11	1	8	6		11	1	11	1
3.	$3\frac{1}{2}$	15	10	12	6		12	2	1	5
4.	$3\frac{11}{16}$	16	6	12	3	1	3	2	5	9
5.	$3\frac{1}{2}$	14	13	10	11	1	9	2	5	2

"From the foregoing results, then, we deduce the following table of the quantities of flour, seconds, and bran, per bushel, from each parcel:—

	Flour.	Pollard.	Bran.	Weight per Bushel.
No.	lbs.	lbs.	lbs.	lbs.
1	$45\frac{1}{11}$	$4\frac{4}{11}$	$10\frac{6}{11}$	60
2	$47\frac{1}{5}$	$4\frac{3}{5}$	10	62
3	$49\frac{5}{7}$	$3\frac{3}{7}$	$8\frac{3}{7}$	$62\frac{6}{7}$
4	$46\frac{23}{59}$	$4\frac{35}{59}$	$8\frac{56}{59}$	$62\frac{23}{59}$
5	$43\frac{1}{7}$	$6\frac{4}{7}$	$9\frac{3}{7}$	$59\frac{5}{7}$

The same data furnish us with the quantities, per cent., of flour, pollard, and bran yielded by each parcel;—thus, 100 lbs. of grain without waste—

	Flour.	Pollard.	Bran.
	lbs.	lbs.	lbs.
No. 1 gives	$75\frac{5}{33}$	$7\frac{9}{33}$	$17\frac{19}{33}$
2 ,,	$76\frac{48}{77}$	$7\frac{11}{77}$	$16\frac{18}{77}$
3 ,,	$80\frac{40}{43}$	$5\frac{18}{43}$	$13\frac{21}{43}$
4 ,,	$77\frac{833}{2211}$	$7\frac{153}{221}$	$14\frac{208}{2211}$
5 ,,	$72\frac{196}{207}$	$11\frac{23}{207}$	$15\frac{195}{207}$

From this it appears, that had not the very green failed in quantity, it is superior to the ripe in quality —making more flour by 2 per cent.; while the raw, No. 3, is superior to all the other varieties. Thus, the bushel of No. 3 gives more flour than the bushel of No. 5 by 6¾ lbs., showing a gain of 15½ per cent. in weight of flour upon equal measures of grain. We also find that 100 lbs. of wheat, No. 3, make $80\frac{42}{43}$ lbs. of flour, while 100 lbs. of No. 5 yields $72\frac{186}{207}$ lbs. —showing an advantage of 7·984, or nearly 8 per cent., in favour of No. 3 upon equal weights of wheat. To those who are acquainted with Mr. Hardcastle it will be unnecessary to say, that neither ignorance nor design produced these results. And, when I state that he devoted his attention for several hours, and a portion of his machinery, to the exclusive trial of these wheats, it will be of little use to add, (though such was the fact) that every operation was conducted under my own eye, and that each parcel underwent an exactly similar process. Indeed, I must say that Mr. H. entered into the investigation with a spirit fully equal to my own, and conducted it with a skill that left me nothing to do but to thank him. And surprising as the results of this investigation may appear—surprising as they appeared to me—I must give Mr. Hardcastle credit for anticipating them in some degree; for, before the operation of grinding was concluded, he expressed to me his pleasure at being chosen to carry out an experiment of such interest; 'as a mark of which interest,' added he, 'I have no hesitation in saying, (and my opinion is confirmed by the senses of a practical miller—the sight, hearing, and touch)—that No. 5, the ripest wheat, grinds the worst—worse even than the greenest; a fact which few would believe unless they saw.' The results, as we have seen, fully confirmed Mr. H.'s opinion; and further examination explained the whole matter. In No. 5 we found a much greater quantity of flinty particles, which would not pass through the flour-sieve, than in any other, —a fact which clearly explained why it should, in millers' parlance, 'grind worst.' The deficiency of No. 5, in yield of flour, when compared with No. 3, was accounted for by the difference in the quantity of the pollard (or sharps), and in the quality of the brans; the bran from No. 5 being coarse and heavy, while that from No. 3 was thin as a bee's wing. 'Should a practical miller examine these brans, and be informed that they were from one sort of wheat,' remarked Mr. Hardcastle at the time, 'he would call No. 5 a very common specimen of grinding, and censure the miller; the other he would term a beautiful piece of workmanship, and say that the man who ground it knew how to prepare his machinery; yet the fact is, one miller and one mill have ground and dressed both.' The flour from the various wheats Mr. Hardcastle declared to be worth, at that time, 2s. 6d. per stone wholesale. The pollard he valued at 1s. 3d.; and the bran at 10d. per stone. Taking the straw at 2d. per stone, the real value of the respective cuttings will stand thus:—

No. 1.

	£	s	d
8st. 12 lbs. of flour, at 2s. 6d. per stone,	1	2	1½
12 lbs. of pollard, at 1s. 3d.	0	1	0¾
2 st. 1 lb. of bran, at 10d.	0	1	8½
22½ st. of straw, at 2d.	0	3	9
Total value of the produce of 20 perches,	1	8	7¾

No. 2.

	£	s	d
8 st. 6 lbs. of flour, at 2s. 6d. per stone,	1	1	0¾
11 lbs. of pollard, at 1s. 3d.	0	0	11¼
1 st. 11 lbs. of bran, at 10d.	0	1	5½
21 st. 3 lbs. of straw, at 2d.	0	3	6¼
Total	1	7	0½

No. 3.

	£	s	d
12 st. 6 lbs. of flour, at 2s. 6d. per stone,	1	11	0¾
12 lbs. of pollard, at 1s. 3d.	0	1	0¾
2 st. 1 lb. of bran, at 10d.	0	1	8½
20 st. 8 lbs. of straw, at 2d.	0	3	5
Total	1	17	3

No. 4.

	£	s	d
12 st. 3 lbs. of flour, at 2s. 6d. per stone,	1	10	6¾
1 st. 3 lbs. of pollard, at 1s. 3d.	0	1	6
2 st. 5 lbs. of bran, at 10d.	0	1	11½
19 st. 2 lbs. of straw, at 2d.	8	3	2¼
Total	1	17	2

No. 5.

	£	s	d
10 st. 11 lbs. of flour, at 2s. 6d. per stone,	1	6	11½
1 st. 9 lbs. of pollard, at 1s. 3d.	0	2	0½
2 st. 5 lbs. of bran, at 10d.	0	1	11½
18 st. of straw, at 2d.	0	3	0
Total	1	13	11½

Giving for the value of an acre of

	£	s	d
No. 1.—cut a month before fully ripe,	11	9	2
No. 2.—do. three weeks,	10	16	4
No. 3.—do. a fortnight,	14	18	0
No. 4.—do. ten days	14	17	0
No. 5.—do. ripe,	13	11	8

The loss, therefore, upon the green plots is respectively £2 : 2 : 6 and £2 : 15 : 4 per acre; and the gain upon the plots (3 and 4) cut raw respectively £1 : 6 : 4 and £1 : 5 : 8 per acre, when compared with the ripe. It will be observed here, that the loss upon No. 2 is greater than upon No. 1, which arises from the former being less in quantity than the latter. But the grain of No. 2 was bolder, and a better sample than No. 1. We have seen from the foregoing tables that it also made more flour to the bushel than No. 1; it will therefore appear strange that the produce should not be equal, at least, to that of the other. In reply to this I would say, that it is scarcely possible to select two plots of ground, the produce from which will be equal in all respects; and therefore a slight variation in the produce may, in any case, be accounted for. In this case, however, another cause operated, I have no doubt, in producing the apparently anomalous result. Thus, owing to the plots of ground being reaped before any other in the neighbourhood, they were, in spite of all precaution, robbed to some extent by the birds. Indeed, I have no doubt but that the loss upon the two cuttings 1 and 2 (especially upon the latter), would have been much less but for this circumstance; for though the desiccation or shrinking of the grain, from being cut too early, undoubtedly caused the quantity by measure of each to be less than that of the later cut samples, it could not, in my opinion, cause a difference of a bushel in 20 perches; nor could it have caused the measure of No. 2 to be less than that of No. 1—a far smaller sample. In order, therefore, to see how much of the deficiency in measure was to be attributed to the shrinking of the grain by drying, and how much to the other accidental circumstances, I took a long glass tube—sealed at the bottom—of ½-inch diameter, and partially filled it with water. Having made a mark on the glass at the point where the water reached, I made another some distance upwards. After this I poured grains of wheat from the sample No. 1 until the water's edge touched the top mark. The tube was then emptied, and a similar operation performed with all the samples. From this I found that it required 1110 grains of No. 1, 1005 of No. 2, and 910 of No. 5, to fill the tube so far that the water rose to the top mark. Between Nos. 3, 4, and 5, I could not, after several trials, find any real difference—the variation scarcely ever exceeding 1 per cent., and that in favour first of one sample and then another. From the foregoing test, however, we learn that, supposing the number of grains upon each portion to be originally the same, $\frac{1}{1110}$, $\frac{1}{1005}$, and $\frac{1}{910}$, will represent the comparative measures or spaces occupied by the produce of Nos. 1, 2, and 5 respectively; whence—

	Bushels.	Bushels.
$\frac{1}{910} : \frac{1}{1110}$ :: $3\frac{1}{2}$:	2·86, the produce of No. 1.	
And		
$\frac{1}{910} : \frac{1}{1005}$ :: $3\frac{1}{2}$:	3·16, the produce of No. 2.	

Now, the value of the flour, bran, and pollard, of 2¾ bushels of No. 1 was found to be £1 : 4 : 10¾; therefore, 2·86 bushels give a value of £1 : 5 : 10½. Similarly, the value of the flour, pollard, and bran of No. 2 was £1 : 3 : 6¼; whence the worth of 3·16 bushels is £1 : 9 : 8¾. To these values of Nos. 1 and 2, add respectively 3s. 9d. and 3s. 6¼d., the value of the straw from each, and we have for estimated produce of 20 perches of No. 1, £1 : 9 : 7½; and of No. 2, £1 : 13 : 3. The following will therefore be as correct an approximation of the values of the acre cut at the times stated, as it is possible to come at:—

No. 1, quite green,	£11	17	0
No. 2, green,	13	6	0
No. 3, raw,	14	18	0
No. 4, not quite so raw,	14	17	4
No. 5, ripe,	13	11	8

Showing a loss of £1 : 14 : 8 per acre upon No. 1, as compared with No. 5; a loss of 5s. 8d. per acre upon No. 2, do. do.; and a gain of £1 : 6 : 4 per acre upon No. 3, as compared with the ripe, and of £3 : 1s. per acre, as compared with the green cut No. 1. Let me here observe, that much as the advantage is on the side of the raw (No. 3) wheat, it would, I have no doubt, have been somewhat more, had not the sheaves been subject, in a slighter degree than Nos. 1 and 2, to the pillage of the birds. For although No. 3 produced as much in measure as No. 5, it is reasonable to suppose that it should have produced more, as the waste caused by reaping and stacking the ripe was much greater than that made in harvesting the raw cut wheat. And in so small a number of shocks, a very few visits from the winged legions were sufficient to carry away more than was wasted of No. 5. But this is of no import: with the yield alike, the advantage of No. 3 over the ripe is striking enough. It is an advantage gained not in any point open to variation or uncertainty: it is not a superiority merely in gross quantity of produce, which many things might have tended to produce; but a superiority in the quality of the article produced,—a better adaptation of the grain to make flour, and that to an extent by no means trifling. Thus, from data already given, we can clearly show that, by wheat being cut raw, we have a gain of 15½ per cent. compared with ripe, of flour, upon equal measures, and a gain in the weight of straw of 14 per cent.,—advantages which afford us a clear gain of 52¾ lbs. of flour upon every quarter of wheat,—a gain of 7s. 4¼d. in the value of every quarter of wheat,—a gain of 7s. 6¼d. in the value of every quarter of wheat, and the straw producing it,—a gain of £1 : 6 : 4 upon every acre producing 28 bushels, and of £1 : 8 : 2½ upon every acre producing 30 bushels, the quantity assumed as the basis of my calculations in my former experiment.

"But there are other advantages arising from the early reaping, which, though they cannot be estimated by pounds, shillings, and pence, are not the less valuable. For the sake of brevity, these advantages may be thus epitomised:—with an additional quantity of flour and straw, already considered, we have a better quality of both, a better chance of securing them, and a saving in securing them.

"The quality of flour as an article of food, and its power of affording nutrition to the body, are universally allowed to depend upon the quantity of gluten it contains; indeed, 'it seems pretty well ascertained,' says Professor Johnston, 'that those varieties of grain which contain the largest amount of gluten yield also the greatest return of flour.' Now, No. 3 here yields a greater return of flour than No. 5; it ought, therefore, to contain the greater proportion of gluten. And such is the case. My own analysis of the flours, in their dry state, gave to the raw sample an advantage of 1¼ per cent. in weight of gluten. In order to test the matter further, I forwarded the samples to Professor Johnston, who favoured me with an analysis. In their ordinary state of moisture, he found them to contain respectively—

No. 3,	19·15 per cent. of gluten
No. 5,	8·9 „ „

Thus proving the statement that the wheats which give the most flour give the best flour. And, although the farmer may not think much of this slight advantage in point of nutritive quality, it is no less a benefit both to the consumer and the producer,—affording to the former more nutritive matter for the same money, and enabling the latter to enjoy the profit of quantity and quality combined.

"That the straw of early cut wheat is of a better quality than that of the ripe, may be clearly seen from the researches of every analyst on the subject, and particularly from the following statement by Professor Johnston. 'The period,' says he, 'at which hay is cut, or corn reaped, materially affects the quantity (by weight) and quality of the produce. It is commonly known that when radishes are left too long in the ground, they become hard and woody—that the soft stem of the young cabbage undergoes a similar change as the plant grows old—and that the artichoke becomes tough and uneatable if left too long uncut. The same natural change goes on in the grasses which are cut for hay. In the blades and stems of the young grasses there is much sugar, which, as they grow up, is gradually changed, first into starch, and then into woody fibre. The more completely the latter change is effected—that is, the riper the plant becomes, the less sugar and starch, both soluble substances, they contain. And though it has been ascertained that the woody fibre is not wholly indigestible, but that the cow, for example, can appropriate a portion of it for food as it passes through her stomach; yet the reader will readily imagine that those parts of the food which dissolve most easily are also likely—other things being equal—to be most nourishing to the animal. It is ascertained, also, that the weight of hay or straw reaped is actually less when allowed to become fully ripe; and therefore, by cutting soon after the plant has attained its greatest height, a larger quantity as well as a better quality of hay will be obtained, while the land also will be less exhausted. The same remarks apply to crops of corn,—both to the straw and to the grain they yield. The rawer the crop is cut, the heavier and the more nourishing the straw. Within three weeks of being fully ripe, the straw begins to diminish in weight; and the longer it remains uncut after that time the lighter it becomes and the less nourishing. On the other hand, the ear, which is sweet and milky a month before it is ripe, gradually consolidates, the sugar changing into starch, and the milk thickening into the gluten and albumen of the flour. As soon as this change is nearly completed, or about a fortnight before ripening, the grain contains the largest proportion of starch and gluten; if reaped at this time, the bushel will be heavier, and will yield the largest quantity of fine flour and the least bran. At this period the grain has a thin skin, and hence the small quantity of bran. But if the crop be still left uncut, the next natural step in the ripening process is to cover the grain with a better protection, a thicker skin. A portion of the starch of the grain is changed into woody fibre, precisely as in the ripening of hay, of the soft shoots of the dog-rose, and of the roots of the common radish. By this change, therefore, the quantity of starch is lessened and the weight of husk increased; hence the diminished yield of flour, and the increased produce of bran. Theory and experience therefore indicate about a fortnight before full ripening as the

most proper time for cutting corn. The skin is then thinner, the grain fuller, the bushel heavier, the yield of flour greater, the quantity of bran less; while at the same time the straw is heavier, and contains more soluble matter than when it is left uncut until it is considered to be fully ripe.'

As a manure too, the straw cut 'raw' is equally superior to the ripe; for, as it is an agricultural axiom that the better the food of an animal is, the better the manure from it, the manure from a stock consuming this straw, containing a fair proportion of nutritive matter, must be more valuable than that from stock consuming the ripe with scarcely any in it. But a great proportion of the farmer's straw is converted into manure without undergoing the process of mastication and digestion. For this purpose the unripe straw is equally preferable, as all unripe vegetables are manures without preparation,—the soluble and nutritive extracts which they contain being the principal agents in forming vegetable manure, —as they not only combine to render the process of decomposition the more rapid, by breaking down the woody fibres, &c. in the manure heap, but are also in their pure and separate states stimulants to vegetation. It may be urged that the increased value of the straw is more in favour of that cut very green (No. 1) than that cut a fortnight later (No. 2.) This is true; but, to produce this increase of value, if we cut our wheat so early as No. 1, we have a desiccation of the grain to such an extent as to diminish the measured produce above 12 per cent.; while, by reaping with No. 2, we are, so far from injuring either sample or measure, actually improving both, and at the same time gaining above 5 per cent. in the weight, and at least as much in the quality of the straw. For the increase of weight in the latter is not produced by a greater produce, but by the presence of a greater portion of those soluble substances which are alike necessary to animal and vegetable life—are alike the nutritive part of food and the quickening principle of manure.

"We come now to the second advantage, the better chance of securing the crop. This is self-evident. We gain a fortnight at the commencement of harvest. If the weather be good, we can secure a great portion of our wheat before we should scarcely have begun upon the old system. If not, we can wait; so, under any circumstances, our chances of securing the grain must be greater. Moreover, if we take a retrospect of the harvests for a number of years, we shall find that nearly all the early harvests have been what we term good ones, *i. e.* good as regards weather and the condition in which the grain was secured. When the peculiarities of our climate, its general fickleness, and its still greater liability to change as the autumn advances, are considered, this will require no explanation. If we look, too, at the later harvests, we shall, I venture to say, find that, in nine cases out of ten, the grain which was cut first was secured in the best condition. As an example of this, the crop of 1839 will suffice. The crops were late, the beginning of reaping the same, and the result was, that in the North of England full 75 per cent. of the whole wheat crop was damaged. And full 75 per cent. of that which was uninjured, I will also venture to say, was that which was cut the first. In Yorkshire this was especially seen; for the earliest wheat was with the greatest difficulty secured. In this village (North Deighton) not a sheaf was in stack till the day before, and on some farms, the very day on which the rainy weather set in. The frequent recurrence of such years as this, will teach the value of even a fortnight better than any thing that can be said here. And that they will recur is beyond a doubt. What has happened once may happen again, but what has frequently happened (as this sort of harvest has,) with the same causes in operation, we are warranted in saying will happen again and often.

"The saving in securing the crop is a double one. In the first place, there is less waste in moving or reaping, and no danger of 'shaking' or 'necking' in strong winds. In the second place, there is an absolute economy in the expense of reaping the crop, which may be thus illustrated:—The busy period of harvest with the farmer generally extends over four or five weeks. In this month a certain portion of his work is done by his own hands, *i. e.* by the regular labourers and servants of the farm; therefore, by beginning a fortnight sooner, and extending the season of harvest over six weeks instead of four, it is evident that these regular servants would cut a much greater proportion of his crop—in fact one-half more. By this he is rendered less dependent on those extraneous 'helps' or 'takers' who, in the seasons of hurry and anxiety, fix their own terms. How often do we, especially in the north, behold a force of reapers in almost every field. The reason is this: the wheat, oats, and barley, are often ripe at one time; and aware as the farmer is of the injury which strong winds and showers would do them, he has to hunt up labourers at any price. And, after all this extra expense, it is extremely probable that, having the whole of his harvest upon his hands at once, he is compelled to let some part of his grain have too little or some too much weather. By commencing his wheat harvest a fortnight earlier, these evils would have been prevented; by the time that his barley and oats were ready, most or all of his wheat would have been cut, and some of it fit for the stack, and that, too, by the exertions of his regular workmen only. And being neither pressed for time nor labourers, his harvest would have been finished at a less expense, and his grain secured very probably in a much better condition. To assign a value for these advantages is, as has been said before, for the farmer himself; and it will not be an insignificant one. For if beginning harvest a fortnight earlier enables him to save a crop from spoiling once in a lifetime,—if the improved quality of his straw as food for his stock allows him to plough out an acre more, or to pasture another acre of clover with feeding stock, instead of mowing it for his lean stock, every grain saved, every extra bushel of corn produced, and every extra head of stock fed, is a benefit to the whole community as well as to himself—is so much added to the gross produce and wealth of the country; there being, in fact, an increased return without an increased outlay.

"I have now but one observation to make on the subject, and though it comes last, it is far from being least worthy of attention; it is, that however little, or however much, we may think of the gain to ourselves accruing from the adoption of any system, it is our duty, as members of society, to avail ourselves of every means of applying the resources the Almighty has given to the use of his creatures, and of developing still further those resources for the benefit of the community at large. When, then, we consider that there are in England and Scotland about 4,000,000 acres of wheat grown annually, producing 12,000,000 quarters of grain, of which three-fourths are allowed to become too ripe—when we consider, that, by cutting this sooner, we should produce an increase of 15½ per cent. of flour, and realize an increased value of 7s. 6¼d. upon each quarter produced, and that we should produce food for 1,362,857 persons over and above what we now produce, and an extra annual income of £512,491,—and when we consider that this income would be so much added to the wealth of the country, that it is equal to the proceeds (at 3 per cent.) of an estate worth £17,083,033, and that the increase of our population demands an increased supply of food, I would

ask, what is our duty in this case? The answer I leave."

All matters connected with the cutting of wheat are fully discussed in the article Reaping and in the other articles there referred to; and most other matters connected with the harvesting of wheat are so nearly the same as in the case of barley, oats, and rye that they need not be again described. Wheat reaped early in the morning with a strong dew, should not be bound up in sheaves till the dew is entirely dried out. When the weather is dry, and the crop is free from succulent weeds or from rank growing clover, wheat may be carted to the rick-yard in a comparatively short time after it is cut down; and if, according to the old practice, it has been allowed to stand uncut till the whole plant has become yellow and exsiccated, it may be stacked almost immediately from the reaping. In consequence of its comparatively great length and firmness of straw, wheat remains opener in the sheaves, both in the shock and in the rick, and therefore dries better in both, and may be carried in correspondingly earlier, than either barley or oats. The best criterion to judge of the fitness either of wheat or of any of the other culmiferous crops for being carried in, is to examine what are called the corn-knots or joints of the straw. If these are succulent and full of sap, it would be dangerous to carry the crop; but when these are dried and dead, it may be carried in with great safety, even although it may be at the time a little wetted by rain. If, however, the crop, or any part of it, is meant to be thrashed early, as for seed or otherwise, it is necessary to allow it to remain in the field till pretty thoroughly dried. When the straw happens to be mixed with succulent weeds, or with rank growing clover and rye-grass, the farmer's patience must be exercised till these are decayed and dried; for if allowed to remain succulent, they would be exceedingly apt to heat the whole rick, and materially damage the quality of the grain. A good practice is to have the shocks thrown down a short time before the sheaves are pitched into the waggon, in order that their butts may dry if damp, and that mice, which may have crept into the sheaves, may escape from them.

The Diseases and Accidents of Wheat.—The injuries to which wheat crops are subject, in the various stages of their growth, are numerous, great, and complicated. And the chief which arise from the weather, are noticed in the articles Accidents and Blight; from animals preying upon the young crop, in the articles Grub and Slug; from fungi in the maturing culms and ears, in the articles Mildew and Smut; from insects in the growing ears or grain, in the article Wheat-Fly; from animals in the yard or barn, in the article Vermin; and from insects preying upon the thrashed grain, in the articles Calandra and Corn-Moth.

The Produce and Composition of Wheat.—The produce of wheat grain varies exceedingly according to soil, manure, tillage, culture, rotation, variety, season, comparative healthiness, and other circumstances. About 35 years ago, when British agriculture was in a much less improved condition than in the present day, 18 bushels per English acre were considered a very poor crop, from 24 to 30 bushels were considered a fair average on farms of medium good soils under good management, 40 bushels were esteemed a large produce on good soils in high order, and from 38 to 55 bushels were occasionally obtained from prime soils under prime management in favourable years; and now, when soils have been much ameliorated by subsoil draining and other arts of georgy,—when manures have received the addition of bones, guano, nitrates, and many special preparations, and can be discriminatingly applied in the new lights of agricultural chemistry,—when tillage, from the breaking up and cleaning of the soil on to the completion of after-culture in spring rolling, may be so much better effected than before by means of recently invented or highly improved implements,—when the rotation of crops is so much more clearly understood in its principles, and may be so much more efficiently carried out by means of recently introduced hybrids and varieties of green-fallow plants,—when the peculiar capacities of particular soils can be brought into play, and the fullest energies of all soils called forth, by means of the minute adaptations to them which are found to exist in the many recently introduced varieties of wheat,—and when the diseases and accidents which affect wheat crops are so much better understood than before, and may, in many instances, be so readily prevented or diminished by recently discovered or recently invented appliances, we might fairly expect that a correspondingly great increase in wheat produce is obtained, if not throughout the whole kingdom, at least throughout all its well-improved districts or on all its enlightenedly conducted farms. But this we fear is far from being the case. Professor Low, in 1834, held "a fair good crop" to be 30 bushels per acre, and estimated the average produce of England at not more than 22 bushels, and that of Scotland at not more than 25; and Messrs. Way and Ogston, the Chemists of the Royal Agricultural College at Cirencester, found the mean produce of more than 40 specimens, grown in favourable circumstances of soil and culture in 1846, to be 28 bushels of the mean weight of 61 lbs. per bushel. The extensive abolition of the good old practice of summer fallowing has possibly acted as diminishingly upon wheat produce as the whole aggregate of improvements has acted augmentingly; and even these improvements themselves have by no means been carried out with the spirit and discrimination which general onlookers are ready to believe.

The weight of the straw of wheat crops is usually estimated at about double that of the grain; but as straw in the rick is commonly somewhat moist, and is usually weighed in a somewhat erroneous manner, this estimate seems to be a good deal above the truth. Messrs. Way and Ogston, by methods of the nicest care, ascertained the proportions between the straw, the chaff, and the grain of nearly 50 specimens in 1846, and at the same time determined the specific gravity of the grain, ascertained the quantity of constitutional water and of ash, resolved the ash into its constituents, and demonstrated the kinds and proportions of mineral matter which must be restored to the soil in order to compensate for what the wheat takes away; and, in all these respects, their report, both in its aggregate bearing upon the average of wheat crops, and in its individual details respecting the particular varieties of the wheats which were experimented on, and respecting the soils on which the several specimens grew, is so valuable that we should be inexcusable if we did not present a large abstract of it to our readers.

"The following table exhibits the weight of straw and chaff in reference to grain, in 11 specimens of wheat from the farm of Cirencester College, the grain being reckoned as 1000:—

No. of Specimen.	Variety of Specimen.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff
			Inches.			
1	Hopeton,	Stonebrash and clay,	36	1107·2	204·3	1311·5
2	Hopeton,	Stonebrash,	38	986·8	206·1	1192·9
3	April Wheat,	Stonebrash,	28	996·8	278·5	1275·3
4	Spring Wheat,	Calcareous clay,	34	962·9	219·0	1181·9
5	Bristol Red,	Brash and clay,	38	955·8	216·0	1171·0
6	Clover's Red,	Stonebrash,	40	978·1	208·4	1186·5
7	Red-Chaff Dantzic,	Brash and clay,	38	1013·2	184·6	1197·8
8	Piper's Thickset,	Ditto,	29	928·0	173·0	1101·0
9	White Chaff,	Ditto,	36	827·3	154·7	982·0
10	Hopeton,	Ditto,	40	1163·3	194·3	1355·0
11	Spalding,	Stonebrash,	38	988·5	222·6	1211·0

With the exception of two specimens, we do not observe any very great dissimilarity in the numbers here given—we allude to April wheat (No. 3) and white-chaff wheat (No. 9). In the first, which is a bearded wheat, the chaff, including the awn, is necessarily high; in the white-chaff wheat, the straw and chaff are both very low. In taking the mean of the 11 wheats, the deviation in these two specimens is of little importance, as it occurs in opposite senses, the one destroying the effect of the other. The mean weight referred to grain as 1000 is—

For the straw,	991·3
,, chaff,	205·6
Straw and chaff,	1196·9

Mean length of the straw, 36 inches.

"We may next collect in a table the results of an estimation on five specimens of Hopeton wheat from Mr. Morton, of Whitfield Example Farm:—

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches.			
38	Hopeton,	Gritty silicious sand,	38	926·9	148·3	1075·2
39	Ditto,	Stiff clay,	43	1009·0	156·1	1165·1
40	Ditto,	Sandy,	42	1066·0	154·1	1220·
41	Ditto,	Clay,	45	1246·0	174·6	1420·6
42	Ditto,	Silicious sand,	44	1167·0	185·3	1352·3

The mean of these results will be found to be—

For the straw,	1083·
,, chaff,	163·6
For the straw and chaff,	1246·6

Mean length of the straw, 42·4 inches.

In these specimens the mean length of the straw and its weight in proportion to the grain are both greater than in those of the other series from the College farm: this is evidently due in a great measure to the method of collecting the crops, Mr. Morton's all being mown, and the others, with two exceptions, reaped.

The next table shows the proportion of grain, straw, and chaff, in 7 specimens of red-straw white wheat from Mr. Morton.

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches.			
43	Red-Straw White,	Silicious sandy loam,	47	1050·0	178·3	1228·3
44	Ditto,	Ditto,	45	1327·0	203·2	1530·2
45	Ditto,	Calcareous, brashy, and shallow,	42	852·5	192·2	1044·7
46	Ditto,	Clay loam,	46	1123·0	205·4	1328·4
47	Ditto,	Calcareous and silicious sand with clay,	42	1313·0	197·0	1510·0
48	Ditto,	Calcareous clay,	36	981·6	180·4	1162·0
49	Ditto,	Adhesive loam,	52	1165·0	240·5	1405·5

The specimens give a mean—

For the straw,	1116·
,, chaff,	199·6
Straw and chaff,	1315·6

Mean length of straw, 44·3 inches.

It will be seen that the highest number in the series does not much exceed 1,500 of straw and chaff to 1,000 of grain. The chaff of the red-straw white wheat, it will be observed, is larger in quantity than that of the Hopeton. This is probably a peculiarity of the variety. How far may this variation in the chaff affect the ripening of the two varieties?

"We next give a table of the same kind, embracing 15 specimens of different kinds of wheat received from Sir J. Johnstone. These were all bagged, and therefore the quantities represent very nearly the total straw; indeed in six cases the entire plant, including the root, was sent to us, and the estimation of straw effected after removing the latter at the distance of an inch and a half from the extremity.

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches.			
13	Creeping wheat,	Clay and grit,	39	957·7	188·0	1145·7
14	Talavera,	Ditto,	44	1175·0	164·9	1339·9
15	White Wheat,	Ditto,	40	1184·0	161·4	1345·4
16	Talavera,	Calcareous loam,	38	1155·0	174·9	1329·9
17	Creeping wheat,	Ditto,	39	1071·0	116·3	1187·3
18	Ditto,	"Hazle loam,"	42	1143·0	198·8	1341·8
19	Ditto,	Heavy tough clay,	42	1032·0	165·8	1197·8
20	Talavera,	Tough clay,	43	1068·0	176·1	1244·1
21	Hammond's wheat,	Free clay loam,	40	932·4	191·2	1123·6
23	Red wheat,	Weak clay loam,	38	919·3	242·9	1162·2
24	White wheat,	Weak sandy clay,	41	1009·0	178·2	1187·2
25	Creeping wheat,	Red clay,	40	981·0	179·5	1160·9
26	Ditto,	Clay and sand,	44	1272·0	179·0	1451·0
27	Ditto,	Ditto,	45	1279·0	185·6	1464·6
28	Ditto,	Calcareous rubble,	45	1192·0	181·1	1373·1

Of the 15 specimens here given, only in one instance does the united weights of straw and chaff reach 1,400; and the greater number of specimens fall far short of this amount. The mean of the whole is—

For the straw,	1091·4
,, chaff,	178·9
Straw and chaff,	1270·3

Mean length of straw, 41·3 inches.

"Let us compare the mean of all these specimens from different localities.

	Length of Straw.	Straw.	Chaff.	Straw and Chaff.
	Inches.			
11 Specimens from College Farm	36·0	991·3	205·6	1196·9
12 Specimens from Mr. Morton	43·3	1099·5	181·6	1281·1
15 Specimens from Sir J. Johnstone	41·3	1091·4	178·9	1270·3

Taking the mean of all these, we shall obtain the following numbers:—

For the straw,	1060·7
,, chaff,	188·7
For the straw and chaff,	1249·4

Mean length of the straw, 40·2 inches.

It would thus appear, from a careful examination of 38 specimens collected promiscuously, that the straw and chaff together never exceed 1,500, the grain being taken as 1,000—or, in other words, that the former are, at the highest computation, one and a half times the weight of the latter; and in these particular cases the length of the straw is very considerable, and certainly beyond the average of this, if not of most other seasons. As, however, in by far the greater number of cases the proportion of straw, including the chaff, falls very far short of this, we have every reason to believe that the mean which we have obtained rightly represents the relation of straw and chaff to grain this year. The number 1,250 of course gives one-fourth part more in weight, or about 17 cwt. of straw and 3 cwt. of chaff to 30 bushels of wheat at 61 lbs. On a farm of 400 acres of ordinary fertility, and cultivated on the four-course system, we might fairly consider that the average produce would amount to 28 bushels an acre of 61 lbs. to the bushel. On the calculation of the proportion of straw and chaff already deduced from our experiments, their united weight from the 100 acres (the grain being in weight $75\frac{3}{4}$ tons) would amount to rather more than $95\frac{1}{4}$ tons, including $14\frac{3}{4}$ tons of chaff. At the same time we must in fairness remark, that all observers agree in ascribing to the character of the season the most marked influence on the quantity of straw in relation to grain. Boussingault mentions crops grown at Bechelbron in two consecutive years, which differed most extraordinarily in this respect. In the first year (1840-41) the season was very wet; the second (1841-42) was remarkable for extreme drought. In these opposite conditions the weight of straw to grain was—

In 1840-41,	as 100 to 40
In 1841-42,	as 100 to 90

Converting these numbers into others which may be compared with our own, we have

	Grain.	Straw.
In 1840-41,	1000	to 4160·2
In 1841-42,	1000	to 1116·0

The latter number very nearly approaches our own mean for this year (1,250); the other instance exhibits a most extraordinary deviation. Boussingault states the ordinary relation of straw to grain at Bechelbron to be as 100 to 38 (or as 2,631, grain being taken at 1,000), and quotes in support of this being a probable average the following results of other continental observers:—

For 100 of straw—			Or grain as 1000.
Thaer	gives	50 of grain	2000 straw.
Podewils	...	35 ...	2857 ...
Berger	...	41 ...	2292 ...
Block	...	33 ...	3030 ...
Dierexen	...	39 ...	2564 ...
Schwertz	...	44 ...	2272 ..

It is not stated whether the chaff is included in the calculation, but we suppose that it is. In the Journal of the Royal Agricultural Society of England will be found many accounts of the estimation of straw and grain of wheat, in which the proportion of straw and chaff to grain is generally found to be between $1\frac{1}{2}$ and $2\frac{1}{2}$ that of the grain. If, then, our results merit confidence, they would plainly prove either that the straw of this year is exceedingly small

in quantity, or if (as we believe) its quantity does not fall far short of average years, that the proportion of straw to grain is usually very much overstated.

"The quantity of chaff in wheat does not, as far as we can discover, depend upon the amount of straw, but bears a general though perceptible relation to the grain. To the latter it stands in the proportion of 1 to 5½ on an average of 1 cwt. of chaff to every 10 bushels of wheat. Both straw and chaff are found in some cases to present singular deviations from the usually observed proportions: this is peculiarly the case in Piper's thickset wheat, Spec. 32, where the straw does not much exceed the half of the weight of the grain—the chaff, however, remaining constant. We do not observe that the soil has exercised much influence on the quantities of straw and chaff—the average of clays, of sandy and calcareous soils, being in our experiments very similar.

"We desire now to point out the connexion which exists between the specific gravity of the grain and the value of different specimens of wheat. The specific gravity of wheat is its true weight, with which no peculiarity of shape or size of the grains, no dampness or roughness of the skin, can interfere. Every farmer knows that the weight per bushel is most materially influenced by these circumstances, and, making allowances for them, is accustomed to consider it as a sure criterion of the value of the sample. It is known that the strength of flour and its fitness for making good bread is due to the gluten contained in it, and corresponds to a considerable extent with the weight per bushel—the greater the weight per bushel the better the flour; but setting aside the accidental differences of skin which are the result of thrashing in damp weather, &c., and taking two wheats as nearly alike as possible in this respect, the question to decide will be—Is the wheat of most pounds to the bushel necessarily the heavier?—in other words, Does it contain more gluten? Is it the best for the baker, the most nutritive for the consumer? We are prepared to show that it is not. The subject of specific gravity is rather difficult for parties unaccustomed to these matters to conceive, and it is particularly so in the case of a body consisting of individual grains like wheat. It is easy to understand and express the relation in weight existing between a cubic foot of water, of marble, and of iron. We should find, if we weighed this quantity of the three substances named, that the marble would weigh nearly three times and the iron seven times as much as the water. But the weight of a given bulk of any substance can only be compared with that of another (for the sake of determining the relative weights of the matter composing them) when there are no interstices or hollows in it. Wood is considered to be lighter than water because it floats upon it, but this is due to the air contained in its pores. Wood is really much heavier than water, and in consequence sawdust will be found very shortly to fall to the bottom of a vessel of water into which it is thrown. Now this reasoning applies equally to wheat. Were the grains of wheat solid bodies of large dimensions, so that they could readily be measured by the rule, or indeed were the grains all exactly of one size, the relative weight of two specimens could easily be made out; but this is not the case. A bushel of wheat is in the same predicament as a mass of wood; we cannot tell the true weight of the matter composing one or the other by weighing a certain measure of it, because the interstices between the grains of two specimens of wheat may differ in the same way as the pores or hollows of two kinds of wood. The weight, then, of any measure of two different grains will not correspond with their relative weight, supposing them solid, and therefore the weight per bushel may differ, the real weight remaining the same, or *vice versa*. This will be better seen if we collect in a table the specific gravities and the weights per bushel of those specimens which we have examined.

No.	Variety.	Soil.	Specific gravity.	Weight per bushel. lbs.	Ash per cent.
1	Hopeton,	Stonebrash and clay,	1·374	60	1·76
2	Ditto,	Stonebrash,	1·342	59	1·81
3	April wheat,	Ditto,	1·387	61	1·79
4	Spring wheat,	Calcareous clay,	1·376	58	1·74
5	Bristol red,	Brash and clay,	1·370	61¾	1·54
6	Clover's red,	Stonebrash,	1·383	61½	1·55
7	Red-chaff Dantzic,	Brash and clay,	1·387	61	1·36
8	Piper's thickset,	Ditto,	1·350	61	1·48
9	White-chaff wheat,	Ditto,	1·313	59	1·54
10	Hopeton,	Ditto,	1·354	61	1·51
11	Spalding,	Stonebrash,	1·377	61	1·81
13	Creeping wheat,	Clay and grit,	1·375	62	1·55
14	Spring wheat,	Sand, clay, and grit,	1·370	62	1·59
15	White wheat,	Clay and grit,	1·368	60	1·68
16	Spring wheat,	Calcareous loam,	1·373	62	1·69
17	Creeping wheat,	Ditto,	1·394	62	1·72
18	Ditto,	Hazel loam,	1·387	61	1·90
19	Ditto,	Heavy tough clay,	1·376	62	1·50
20	Spring wheat,	Tough clay,	1·363	62	1·60
21	Hammond's wheat,	Free clay loam,	1·354	60	1·94
22	Red Britannia,	Strong clay,	1·369	62	1·82
23	Red wheat,	Weak clay loam,	1·352	60	1·75
24	White wheat,	Weak sandy clay,	1·351	61	1·59
25	Creeping wheat,	Red clay,	1·367	61½	1·70
26	Ditto,	Clay and sand,	1·365	62	1·73
27	Ditto,	Ditto,	1·372	62¾	1·65
28	Ditto,	Calcareous rubble,	1·394	63	1·71
29	Red-straw white,	Six inches good loam,	1·385	61	1·70
30	Hopeton,	Three inches loam,	1·412	60	1·56
31	Ditto,	Flint and chalk,	1·356	56	1·63
32	Piper's thickset,	Good loam,	1·339	59	1·73
33	White wheat,	Alluvial,	1·382	60	1·60
38	Hopeton,	Gritty silicious sand,	1·403	63	1·61
39	Ditto,	Stiff clay,	1·382	61½	1·63
40	Ditto,	Sandy,	1·396	62	1·71
41	Ditto,	Clay,	1·393	60	1·69
42	Ditto,	Silicious sand,	1·391	62	1·76
43	Red-straw white,	Silicious sandy loam,	1·381	62	1·72
44	Ditto,	Ditto,	1·392	62	1·73
45	Ditto,	Calcareous, brashy, and shallow,	1·362	61	1·61
46	Ditto,	Clay loam,	1·413	63	1·60
47	Ditto,	Calcareous and silicious sand,	1·377	63	1·90
48	Ditto,	Calcareous clay,	1·388	62½	1·73
49	Ditto,	Adhesive loam,	1·386	61	1·71

In this table we cannot fail to observe a certain degree of connection between the specific gravity and the weight per bushel in many cases. Thus specimens 2, 9, 21, 23, and 31 correspond in having low specific gravities and low weights per bushel, whilst several specimens of high specific gravity give also a good weight per bushel, as specimens 28, 38, and 46. But on the other hand, in the greater number of instances the relation existing between these two circumstances is anything but clear: thus in several samples of the same weight per bushel, the specific gravity is widely different; we need only instance specimens 21 and 30. A glance at the table will supply many other such examples.

"The quantity of water in the different parts of the wheat plant next requires notice. A certain amount of water appears to be natural to the grain, straw, and chaff of wheat. If, when damp, they are exposed in a moderately warm and dry atmosphere, they soon lose their superabundant moisture, becoming to all appearance dry, but still retaining a certain and very considerable portion of water. This water is not, however, essential, although natural to them: for either of the three may by a heat under that of boiling water be perfectly dried without apparent injury or alteration of structure. The water in the grain varies between the limits of 9·5 and 13·5 per cent.: in the greater number of instances it is, however, between 10 and 12 per cent. The mean of all the specimens examined (62 in number) is found to be 11·69 per cent. In the straw the quantity of water ranges between 10·5 and 14·00 per cent.; the mean on 40 specimens being 11·96. The

chaff, when dried, loses from 11 to 14 per cent. of water; in one case (spec. 21) it amounted to 16 per cent., the crop having been injured by floods. The mean proportion of water in the chaff of wheat taken on 40 specimens is 12·21 per cent. It would thus appear that nearly one-eighth part of the whole wheat crop consists of water—about 20 tons of which are therefore removed by it from a farm of 400 acres.

"We now come to consider the mineral matter in the different parts of wheat, and first as to its quantity. The following tables give the amount of variation in the ash of all the specimens before described:—

No. of spec.	Name of Specimen.	Clay Soils.			Sandy (Silicious) Soils.			Calcareous Soils.		
		Ash of Grain.	Ash of Straw.	Ash of Chaff.	Ash of Grain.	Ash of Straw.	Ash of Chaff.	Ash of Grain.	Ash of Straw.	Ash of Chaff.
1	Hopeton,	1·76	3·85	9·18	...	...	...	...	...	...
2	Hopeton,	...	...	...	...	...	...	1·81	3·77	9·31
3	April wheat,	...	...	...	...	...	...	1·79	3·73	6·94
4	Spring wheat,	1·74	4·60	11·56	...	...	...	...	...	...
5	Bristol red,	...	...	...	...	...	...	1·54	3·92	11·98
6	Clover's red,	...	...	...	...	...	...	1·55	3·20	7·61
7	Red-chaff Dantzic,	...	...	...	...	...	...	1·36	4·87	12·97
8	Piper's thickset,	...	...	...	...	...	...	1·48	5·00	8·52
9	White-chaff wheat	...	...	...	...	...	...	1·54	4·76	10·27
10	Hopeton,	...	...	...	...	...	...	1·51	3·77	11·34
11	Spalding,	...	...	...	...	...	...	1·81	3·57	7·30
13	Creeping,	...	...	...	...	...	...	1·55	4·33	16·46
14	Talavera,	...	...	...	...	...	...	1·59	4·00	14·38
15	White wheat,	...	...	...	...	...	...	1·68	3·36	13·00
16	Talavera,	...	...	...	...	...	...	1·69	5·08	16·47
17	Creeping wheat,	...	...	...	...	...	...	1·72	5·50	15·06
18	Creeping wheat,	...	...	...	...	...	...	1·90	6·83	14·34
19	Creeping,	1·50	4·08	11·97	...	...	...	...	...	...
20	Talavera,	1·60	5·98	15·24	...	...	...	...	...	...
21	Hammond's,	1·94	4·65	13·71	...	...	...	...	...	...
22	Red Britannia,	1·82	5·16	14·48	...	...	...	...	...	...
23	Red wheat,	1·75	5·65	13·02	...	...	...	...	...	...
24	White wheat,	1·59	4·00	13·46	...	...	...	...	...	...
25	Creeping wheat,	1·70	3·73	13·40	...	...	...	...	...	...
26		...	...	...	...	...	...	...	...	...
27		...	...	...	...	...	...	...	...	...
28		...	...	...	...	...	...	...	...	...
29	Red-straw wheat,	1·70	...	...	...	...	...	...	...	...
30	Hopeton,	1·56	...	...	...	...	...	...	...	...
31		...	...	...	...	...	...	...	...	...
32	Piper's thickset,	1·73	11·00	15·41	...	...	...	...	...	...
33		...	...	...	...	...	...	...	...	...
38	Hopeton,	...	...	...	1·61	4·09	12·45	...	...	...
39	Hopeton,	1·63	4·27	14·29	...	...	...	...	...	...
40	Hopeton,	...	...	...	1·71	4·07	11·77	...	...	...
41	Hopeton,	1·69	5·15	12·24	...	...	...	...	...	...
42	Hopeton,	...	...	...	1·76	4·16	10·36	...	...	...
43	Red-straw white,	...	...	...	1·72	4·24	10·08	...	...	...
44	Red-straw white,	...	...	...	1·73	4·68	13·78	...	...	...
45		...	...	...	...	...	...	1·61	2·74	7·04
46	Red-straw white,	1·60	4·20	9·45	...	...	...	...	...	...
47		...	...	...	...	...	...	1·90	7·36	15·88
48		...	...	...	...	...	...	...	...	...
49	Red-straw white,	1·71	5·07	11·27	...	...	...	...	...	...

It will be convenient to consider in the first place the quantity of ash in the straw and chaff, in order that the mineral matter of the grain, both as regards its quantity and quality, may come under our notice at one time. The quantity of ash of wheat straw is usually comprised within the limits of 3·5 and 5 per cent. of its weight. There are, as will be seen by the table, deviations from this proportion—one specimen (No. 45) giving only 2·74 per cent., whilst in Piper's thickset (spec. 32) the per centage is as high as 11. There is no very evident connection between the quantity of ash and the soil upon which the specimen has grown; but if we may judge from the mean of the instances in the tables, it would appear that straw from clays contains the most ash—that from calcareous soils containing less, but more than the produce of sandy (silicious) soils. The variety of wheat would seem to control the proportion of ash of the straw; and the relative strength of different specimens is certainly to some extent dependent upon its amount. Thus in Piper's thickset (spec. 32), which possesses a straw of unusual strength, the proportion of ash is very great, more than doubling the usual average. This peculiarity is not observable in another specimen of straw of the same wheat (spec. No. 8); but the singular lowness of ash in this instance is due in some way to the soil. The mean of 40 specimens of straw given in the table will be found to be 4·50, or about 100 lbs. of ash for every ton of straw. The greatest quantity of ash removed from an acre by the straw of any crop which we have examined is 243 lbs. (spec. 47); in this case the per centage of ash is very high. The amount of mineral matter removed from the soil by the straw will of course be dependent on the quantity of straw itself, and therefore on the season. The proportion of ash in the chaff varies between the limits of 7 and 16 per cent.; more frequently, however, being found between 12 and 15 per cent.; as in the case of the straw, the silicious soils give chaff containing the least ash, and clays the most, the calcareous soils being interme-

diate in this respect. The ash in the chaff, indeed, in many instances corresponds with that of the straw. Thus in specimens 1, 2, 3, 4, 6, 11, we have a very low per centage of ash both in the straw and chaff; and this might be expected, as the chaff is only a prolongation of the straw. The 40 specimens of chaff give a mean ash of 12·25 per cent.; so that one-eighth part of the chaff of wheat is mineral matter. We have already shown that chaff contains on an average 12·25 per cent. of water. No less than one-fourth, then, of its whole weight consists of matter incapable of affording nourishment to animals; this should be taken into account in estimating the feeding properties of wheat-chaff—every ton of it being equivalent to 15 cwt. only of solid vegetable food. According to the calculation just given, a ton of chaff would contain 274 lbs. (about 2½ cwt.) of mineral matter. The largest amount removed from an acre by the chaff in any of the crops described, is seen in specimens 32 and 33, where it reaches 85 lbs.

"Of the ash in the grain:—From the last table it will be seen that the quantity of ash for a given weight of grain is not by any means constant, though confined within more narrow limits than that of the straw and chaff. The extreme points, high and low, are found to be 1·36 (spec. 7) and 1·97 (spec. 35); but the greater number of specimens have afforded from 1·5 to 1·7 per cent. of mineral matter. The analysis of 62 specimens of the grain has afforded us a mean of 1·67 per cent. This quantity of ash appears of very trifling importance, but will be seen, when we speak of its composition, to be by no means so insignificant as it would at first sight appear. Neither is it small when taken on a large amount of crop. A bushel (of 61 lbs.) of grain will upon the average contain exactly 1 lb. of mineral matter. The crop of an acre (28 bushels) will carry off ¼ cwt.; and therefore from a farm of 400 acres, on our former calculation, no less than one ton and a quarter of mineral matter will be removed by the grain alone.

"We naturally ask, what circumstances influence the quantity of ash in the grain of wheat? We have given the lists of soils and varieties in the table, in order to answer this question as far as the data before us will allow. The influence of variety on the quantity of ash is not very evident, for we have five specimens of Hopeton, and 7 of red-straw white wheat, which, with one exception, give nearly the same per centage of ash. Piper's thickset and red Britannia wheat (specimens 8, 22, 32), although very peculiar in some respects, do not exhibit any marked deviation with regard to the quantity of ash in the grain. On the other hand, the character of the soil would seem to have but little to do with the matter; in the list of specimens grown on clay, the same differences are observed as in those from silicious or calcareous soils, whilst the mean of the three affords very little deviation. Again, Mr. Morton's specimens of red-straw white and Hopeton wheat, although grown on different soils, possess very little latitude in the quantity of ash. In specimens 38 and 39, 40 and 41, we have very strong evidence against the belief that the soil alone affects the quantity of the ash in the grain of wheat. The two former of these are from the same field, half of which is sand, the other half clay; the two latter, from another field, half sand, half clay.

		Per cent. of ash.
Spec. 38,	Hopeton wheat—silicious sand,	1·61
„ 39,	„ clay,	1·63
„ 40,	„ sand,	1·71
„ 41,	„ clay,	1·69

It is clear that in these instances no alteration in the quantity of mineral matter of the grain is produced by the very opposite description of soil on which the crops were grown. Again, does climate exercise any influence on the quantity of ash of wheat? So far as the differences of locality afforded by Sir John Johnstone's specimens in Yorkshire, Mr. Huxtable's in Dorsetshire, Mr. Morton's in the vale of Gloucester, and our own on the Cotswolds, can afford an answer to this question, it is already given. Climate does not exert any marked influence on the quantity of ash in the grain. We have, however, better instances than these, in the result of the estimation of ash in several specimens of foreign grain:—

French wheat,	1·55	Rostock wheat,	1·61
Egyptian wheat,	1·97	Spanish wheat,	1.65
Odessa wheat,	1·50	Dantzic wheat,	1·71
Marianople wheat,	1·70	Ditto,	1·46
Rostock wheat,	1·46	Ditto,	1·47

Here we observe differences which are as great, though not greater than in specimens from the soils of our own country. Warm climates cannot be said to favour the abstraction (by the grain) of mineral matter from the soil, for in Spanish wheat we have a low per centage of ash; and although the Egyptian grain gives more ash than any other specimen we have examined, the excess is hardly worth notice.

Spec. —.	Egyptian wheat gives	1·97
„ 21.	From Yorkshire	1·94
„ 53.	April wheat from Worcester	1·92
„ 47.	From Mr. Morton	1·90

We cannot then give to the climate credit for creating differences in respect to the quantity of ash in the grain. If climate create no difference, aspect and locality are equally insufficient to account for the observed discrepancies. But though the character of the soil (that is, whether it be light or heavy, silicious or calcareous), though the variety of the crop, the climate, aspect, and locality, do not seem materially or uniformly to influence the quantity of ash, there is still another circumstance which may in part affect the question;—this is, the mineral constitution of the soil, irrespective of texture—the quantity and condition of mineral food at the command of the crop; and although we cannot speak positively on the point, there is evidence in favour of the view, which does not exist for any of the others. * * * It is curious that the larger the crop in any instance, the smaller in general is the per centage of ash in the grain. Twenty-eight bushels has been shown to be the mean crop per acre of the specimens we have examined, and 1·67 per cent. the amount of ash. If we collect, on the one hand, all those specimens which exceed, and, on the other, those which fall short of this per centage, taking the mean of their quantities and of the per centage of ash, we shall obtain the following result:—
The mean of specimens affording less than 1·67 per cent. of ash, is

30 bushels of grain to the acre,
And 1·56 per cent. of ash.

Of those affording more than 1·67 per cent. of ash, the mean is

27 bushels of grain to the acre,
And 1·76 per cent. of ash.

Now

	Bushels.	Ash.		Bushels.	Ash.
As	30	1·76	: :	27	1·58:

very nearly the amount which our results indicate. The quantity of ash then would appear to be inversely as the crop—that is, the quantity of mineral matter does not increase with the amount of crop, but is less in proportion to the vegetable matter in the large than in the smaller produce. This would seem to lead to the inference that the quantity of mineral matter present in plants is to a certain extent regulated by the abundance of the supply.

"Of the chemical composition of the ash of wheat grain:—The following table shows the amount of each of the mineral ingredients in 26 specimens of the ash of wheat:—

No. of Specimen.	Variety.	Soil.	Ash per cent.	Silica.	Phos Acid.	Sulph. Acid.	Carb. Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chlor. of Sod.
2	Hopeton, .	Stonebrash, .	1·81	2·84	47·00	0·24	0·23	3·20	12·71	0·60	33·15	...	...
10	Ditto, . .	Calcareous brash & clay	1·51	1·41	46·18	0·48	...	2·82	13·99	0·00	33·00	2·07	...
11	Spalding, .	Calcareous,	1 81	2·23	48·21	0·11	0·22	2·88	11·06	0·23	29·76	5·26	...
12	Hopeton, .	.	1·48	5·91	41·22	1·91	...	4·29	13·57	1·36	27·06	4·08	0·55
26	Creeping wheat,	Clay and sand,	1·73	5·32	46·49	0·61	...	1·50	12·35	0·22	31·18	2·42	...
27	Ditto, .	Ditto, .	1·65	2·55	45·64	1·55	...	6·76	13·06	0·11	28·89	1·40	...
28	Ditto, .	Calcareous rubble, .	1·71	1·34	48·53	...	...	3·72	12·74	1·40	30·94	1·28	...
29	Red-straw white,	Loam (green-sand),	1·70	9·71	40·91	0·08	0·16	1·45	9·53	3·34	31·00	2·54	0·34
30	Hopeton, .	Loam, . .	1·56	2·28	45·73	0·32	...	2·06	10·94	2·04	32·24	4·06	0·27
31	Hopeton, . .	Flint and chalk, .	1·63	4·43	45·30	0·59	...	1 83	12·43	1·76	29·92	6·08	0·64
34	French wheat,	. .	1·55	3·05	43·47	0·35	...	3·47	13·94	0·97	32·39	2·32	...
35	Egyptian wheat,	. .	1·97	4·97	41 03	0·18	...	4·34	11·12	1·18	36·60	0·53	...
36	Odessa, .	. .	1·50	4·48	45·80	...	...	3 17	14·28	0·89	30·30	1·00	...
37	Marianople, .	. .	1·70	4·00	34·44	0·24	...	2·05	14·09	trace	35·77	9·06	...
38	Hopeton, .	Silicious sand, .	1·61	4·23	39·97	0·15	...	1·32	13·26	...	36·43	4·62	...
39	Ditto, . .	Stiff clay,	1·63	3·05	47·33	...	...	4·43	9·32	0·35	32·05	3·38	...
40	Ditto, .	Sandy, . . .	1·71	5·63	43·98	0·21	...	1·80	11·69	0·29	34·51	1·87	...
41	Ditto, .	Clay, . . .	1·69	3·69	49·22	0·18	...	2·51	12·38	0·08	30·32	0·07	1·60
42	Ditto, .	Silicious sand,	1·76	3·29	44·44	...	...	8·21	9 67	0·08	32·14	2·14	...
43	Red-straw white,	Silicious sandy loam,	1·72	2·14	49·58	0·60	...	3·27	13·75	0·23	29·75	0·64	...
44	Ditto, .	Ditto, . .	1·73	2·63	47·44	...	...	3·39	14·05	0·67	29·91	1·87	...
45	Ditto, .	Calcareous (carbonif),	1·61	2·76	47·38	0·07	...	6·87	11·46	0·07	30·13	1·25	...
46	Ditto, .	Clay loam, . .	1·60	3·89	46·79	...	...	1·15	13·39	0·91	30·02	3·82	...
47	Ditto, .	Calcareous and silicious sand and clay	1·90	2·17	46 61	0·44	...	5·05	14·22	0·09	29·17	2·20	...
48	Ditto, .	Magnesian clay, .	1·73	2·05	46·99	0·24	...	6·78	12·76	2·32	26·70	2·12	...
50	White wheat,	Chalk, . .	1·84	5·46	40·57	0·32	...	3·21	9·56	2·06	34·26	4·53	...

It will be seen that the first named, silica, constitutes only a very small proportion of the whole ash; it probably exists only in the skin as a mechanical protection to the grain; in quantity it varies between the limits of 1·30 and 6·00 per cent.; in one instance however the ash contains as much as 9·71 per cent. of this substance, Spec. 29. The specimen in which this unusually large quantity of silica occurs, is also remarkable for the very large proportion of oxide of iron present in its ash; it was grown on the 'green-sand,' and hence in all probability the peculiarity referred to. The green-sand owes its colour to the large quantity of silicate of protoxide of iron existing in it. When decomposed by liming, or water containing carbonic acid, it would furnish an abundant supply of both these substances, which would pass into the plant. The average proportion of silica in the ash of wheat upon the 28 specimens in the table is 3·66 per cent. Phosphoric acid, the next body in the table, is certainly the most important of all the mineral ingredients of wheat, both on account of the large proportion of it which exists in the ash, and the very small extent to which it is present in soils. The ash of wheat contains a quantity of this substance, varying between 40 and 50 per cent. of its weight. In one specimen however (No. 37) the phosphoric acid does not exceed 35 per cent.; but this result does not accord with any other we have obtained. The specimen alluded to is from Marianople; it is in peculiarly small and thin grains, almost approaching in appearance those of rye; it is of interest also in containing a large proportion of soda, not in the place of potash, but in addition to the usual amount of the latter alkali. Specimens 41 and 43 exhibit the highest amount of phosphoric acid in any of the ashes. The mean of phosphoric acid in all the specimens is 45·00 per cent. of the ash. A bushel of wheat of 61 lbs., containing 1·67 per cent. of mineral matter, would require $7\frac{3}{10}$ oz., or taking 28 bushels an acre as an average, we should remove from the soil in the grain of every acre of wheat 12 lbs. 3 oz. The largest amount removed in any crop examined is seen in specimen 47, where it reaches 22 lbs. 5 oz. This sample has been before noticed, from the large amount of ash taken off in the straw; it is in all respects an extreme case, the ash of the grain, the straw, and the chaff, being all unusually high. The large amount of crop with these high percentages renders the specimen the most exhausting of all those which have fallen under our notice. Sulphuric acid is generally present in the ash of wheat, though in small proportion; it does not exceed in any instance 2·00 per cent., and is usually much less than this. The mean quantity of this acid in the ash is 0·34 per cent., and the largest amount removed by an acre of wheat (in this grain) 8 oz. Carbonic acid is an ingredient of many ashes; but in the grain of wheat it is seldom met with. The presence of carbonic acid in an ash indicates the existence of organic acids combined with lime, &c., in the plant. The grain of wheat, however, would appear in its matured state never to possess any such organic salts; and consequently the column appropriated for this acid in the table is almost void. Lime is another ingredient in the ash of wheat: in quantity it varies between 1·5 and 8·00 per cent., being more frequently near the former than the latter number. The mean quantity is 3·61. The largest amount removed from an acre is seen in Spec. 42, where it is 3 lbs. 9 oz. Magnesia is a highly important constituent of plant ashes: in wheat it varies between 9·00 and 14·00 per cent. of the ash—more often however being found to constitute 11 or 12 per cent. of the mineral matter. Our analyses give us as a mean 12·36 per cent. A bushel of 61 lbs. contains 2 oz., and an acre of 28 bushels will remove 3 lbs. 8 oz. The largest quantity of magnesia removed in any crop examined by us was 6 lbs. 13 oz. (Spec. 47). Peroxide of iron exists to a small extent in the ash of wheat: its quantity varies between 0·25 and 3·5, the smaller number being nearer the ordinary quantity. It is remarkable that those specimens which contain most iron are from the chalk districts, or analogous soils. The average proportion of peroxide of iron is 0·81, and the largest amount removed from an acre (Spec. 29) 1 lb. 6 oz. Potash is, next to phosphoric acid, the most considerable and important of all the substances which exist in wheat ash: in quantity it varies between 27 and 37 per cent., having about the same latitude as phosphoric acid. The mean of 26 specimens is 31·37. A bushel of wheat (61 lbs.) will contain 5 oz., and an acre of 28 bushels will carry off 8 lbs. 15 oz. The largest quantity described in the Report as removed from an acre is 14 lbs. Soda is an alkali scarcely ever entirely absent from wheat, but present only in small quantity. When compared with potash, it varies between 1 and 5 per cent. of the ash. In one instance, that of the Marianople wheat before mentioned, its quantity is comparatively large, reaching 9 per cent.; but we have as yet met with nothing to induce us to adopt the opinion of Liebig, of the substitution of one alkali for another. At all events

this does not appear a usual occurrence. We have not certainly examined any specimens grown in soils where the total absence of the other alkali would necessitate a plant to assimilate soda; but were this possible without great injury to the health of the plant, or defect in quality and quantity of the produce, why do we not find it more frequently the case? If it be indifferent to the plant whether the alkali furnished it be potash or soda, why should the quantity of the latter seldom exceed a sixth part of the former? Again, in guano we have always abundance of common salt and other salts of soda, and yet in Spec. 26, where guano was applied, the proportion of soda does not exceed the mean, which is 2·72. Chlorine in combination with sodium as common salt, will be seen to be present in some two or three specimens of wheat, but only in very minute quantity; and it is singular that in two of the three instances where it occurs, an unusually large proportion of oxide of iron is also present, as if the same circumstances had led to the peculiarity in both cases. Possibly in these instances the wheat was not fully matured, and these bodies would come under the title of 'accidental ingredients.' The absence of soda in any quantity, either as soda or as common salt, from both the grain and straw, would seem incompatible with the statement to which much attention has lately been drawn, that common salt is a manure for wheat; or rather perhaps we should say, that it is an argument in favour of the theory which supposes the existence of two distinct classes of manures—one serving as food for plants, the other assisting in preparing that food, or in effecting some other desirable object in the amelioration of the soil. In the first of these ways, common salt certainly can have no influence on wheat: it cannot serve as food for the wheat crop, because it is not required, and the little soda existing in the ash, if essential, is always abundantly supplied by the soil. Common salt probably owes its efficacy in part to the power which it possesses of absorbing and retaining moisture—a tendency which would insure a certain though small supply of moisture to the roots in the driest seasons: it is also poisonous to the wire-worm and other depredators on this crop. We find, then, that in the ash of different specimens of wheat deviations in the proportions of its several ingredients occur, which, although they do not destroy the principle of uniformity of composition upon which the whole interest of the subject depends, yet tend very materially to interfere with its simplicity.

"It will be seen that we have only in one instance analyzed the ash of straw and chaff separately (spec. 46). In the other instances the straw was burnt with the quantity of chaff belonging to it—very perfect and unbroken specimens of average length being selected. It will be manifest that, however desirable a separate analysis in each case might be, the time involved by it will not admit of such a proceeding. The agricultural distribution of the crop is divided into grain, and straw, and chaff, the ash of the former being entirely removed, that of the latter being returned to the soil from the manure heap. The following table exhibits the analyses of nine specimens of wheat straw, with the proportion of chaff belonging to it:—

No. of spec.	Variety.	Soil.	Silica.	Phosph. Acid.	Sulph. Acid.	Carb. Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chlor. Sodium.	Ash of Chaff.	Ash of Straw.
26	Creeping,	Clay and sand,	73·57	5·51	2·14	...	5·91	1·25	0·07	10·51	1·03	...	15·40	4·22
27	Ditto, .	Ditto, .	69·66	6·62	3·95	...	7·46	1·56	0·28	10·31	0·13	...	13·04	4·60
28	Ditto,	Calcareous rubble,	69·94	8·54	2·33	...	4·94	1·43	0·06	12·48	0·25	...	16·54	4·30
40	Hopeton, .	Sand, .	69·36	5·24	4·45	...	6·96	1·45	0·73	11·79	...	...	11·77	4·07
42	Ditto,	Silicious sand, .	67·10	7·05	5·59	...	4·44	3·27	1·54	10·03	0·85	...	10·36	4·16
44	Red-straw white,	Silicious sandy loam, .	70·50	5·77	3·31	...	3·53	3·29	0·14	12·76	0·68	...	13·78	4·68
45	Ditto, .	Cacareous brash,	71·49	3·37	2·28	...	7·34	3·53	1·11	9·47	1·39	...	7·04	2·74
46	Ditto,	Clay loam, .	68·92	3·21	2·21	...	5·63	1·76	0·43	15·50	2·29	...	9·43	4·20
48	Ditto, .	Calcareous clay, dolomitic,	66·13	8·85	2·23	...	6·82	3·62	0·54	11·76	...	...	9·63	4·95

The variation in the composition of the mixed ash of the several specimens in the table is not very great. Sulphuric acid and lime are present in considerable quantity in the straw, but the specimen of chaff which we have examined did not contain the former, and the latter only in small quantity. We give here a table of the quantity of the different mineral matters contained in a ton of straw and of chaff; and also, for comparison, a calculation of the average quantity of these substances removed by the grain, straw, and chaff of an acre, calculated as before at 28 bushels of 61 lbs.

	Mineral matters in 100 parts of Straw Ash.	Mineral matters in 100 parts of Chaff Ash.	In a ton of Straw.	In a ton of Chaff.	Removed from an Acre.	
					In 28 bushels of Grain, at 61 lbs. (1792 lbs.)	In 2109 lbs. of Straw and Chaff (18 cwt. 91 lbs.)
			lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Silica, . . .	63·89	81·22	60 0	172 3	1 $0\frac{6}{10}$	83 8
Phosphoric acid,	2·75	4·31	2 8	9 2	12 13	7 3
Sulphuric acid, .	3·09	...	2 14	...	0 $1\frac{5}{10}$	3 12
Lime, . . .	7·42	1·88	7 0	4 0	1 $0\frac{3}{10}$	7 1
Magnesia, .	1·94	1·27	1 13	2 11	3 $8\frac{3}{10}$	2 13
Peroxide of iron,	0·45	0·37	0 6	0 14	0 $3\frac{6}{10}$	0 10
Potash, . . .	17·98	9·14	17 0	19 6	8 15	13 15
Soda, . . .	2·47	1·79	2 5	3 12	0 $12\frac{3}{10}$	0 13
	99·99	99·98	93 14	212 0	28 $6\frac{6}{10}$	119 11

From this table we may learn that the straw and chaff of a given amount of crop (on the average of this year) remove from the soil together very little more than half the phosphoric acid contained in the grain—at the same time, however, requiring twice as much potash. The quantity of silica removed in the whole produce is very considerable, ¾ cwt. of this substance being required for a very moderate crop. The addition of silicate of potash to the land must be tolerably liberal if it is wished to supply by its means the silica required for the wheat crop. A comparison of columns 3 and 4 will show us that, weight for weight, wheat chaff contains three times as much silica and phosphoric acid as the straw; and although, from the quantity of mineral matter it contains, and the woody nature of its vegetable substance, it may not be so nutritious a food for animals as the straw, the manure into which it is converted must be regarded as much more valuable than that produced from the latter.

"We may fairly conclude that, in round numbers, an average crop of wheat would remove from the soil in the grain, straw, and chaff per acre,

84 lbs. of silica.
20 lbs. of phosphoric acid.
4 lbs. of sulphuric acid.
8 lbs. of lime.
6 lbs. of magnesia.
1 lb. peroxide of iron.
23 lbs. of potash.
1½ lb. of soda.

Of these substances three may be considered as non-essentials: these are, the lime, the peroxide of iron, and the soda, all of which, if the plant requires them, it may readily obtain from almost any soil. To supply the other ingredients in the form of manure of mineral composition alone, we must employ an alkaline silicate, phosphate of lime, and a salt of magnesia. The silicates of potash and of soda, as they are manufactured for agricultural purposes, are compounds of very varying constitution. Of silicate of potash, the average amount required for the supply of 84 lbs. of silica would probably be about 2 or 2½ cwts. It is plain that the quantity of potash required by the crop is small when compared with that which would be added in the requisite dose of silicate of potash. We would therefore recommend silicate of soda as a more economical method of supplying this mineral ingredient of plants. The potash must then be applied in another form. The total phosphoric acid of the wheat crop would be furnished in ¾ cwt. or 1 cwt. of unburnt bones; the magnesia by 40 lbs. of sulphate of magnesia (Epsom salts;) and the potash by about 35 lbs. of carbonate (pearl-ash,) or 50 lbs. of nitrate (saltpetre;) but this last addition will be unnecessary if silicate of potash be employed: the necessary top-dressings will then be—

2½ cwt. silicate of potash,
1 cwt. of crushed bones,
40 lbs. sulphate of magnesia.

Taking into consideration, however, the very gradual solution of the phosphate of lime of bones, it would no doubt be better to adopt another form of top-dressing for wheat. The following would perhaps be a better application:—

2 cwt. of silicate of soda,
1 cwt. of bones dissolved in
½ cwt. of oil of vitriol,
40 lbs. of sulphate of magnesia, and
35 lbs. of carbonate of potash.

The bones should be dissolved in the acid previously diluted with an equal measure of water: when they become thoroughly broken down, the sulphate of magnesia and carbonate of potash should be added, and the whole well stirred and left at rest for twenty-four hours. At the end of this time the mixture would in all probability be found sufficiently dry, when broken up, to be distributed by the hand; it might otherwise be mixed with ashes or mould, in order to attain the proper condition. We have already remarked, that of the total silica required by the wheat, three-fourths belong to the straw, the remainder being found in the chaff and grain. On the other hand, by far the largest proportion of phosphoric acid is appropriated by the grain. Reasoning upon these facts, we should endeavour, as far as possible, to supply the several ingredients at the time when they are wanted. Two-thirds of the silicate of soda and one-third of the prepared top-dressing might be applied to the young plant very early in the spring; the remainder of both should be reserved and applied as late as practicable, in order that they may be at the command of the plant as the ear fills and the straw and chaff strengthen. In many soils, such as stiff clays, and in all localities where the soil is formed from granitic or other primary rocks, the addition of silicates will be an unnecessary outlay of money; but the other mixture is comparatively inexpensive, and would always more than remunerate the farmer, if not in the wheat, at least at some other period of the rotation. The advantage of the method of application here proposed mainly consists in the use of soluble phosphates, such as those of potash and magnesia, which are produced when the materials before mentioned are mixed together; for this purpose, however, the employment of sulphuric acid to dissolve the bones is indispensable. It is quite probable that such a top-dressing, from its solubility and tendency to absorb moisture, would take effect when the season is too dry to allow of other applications being made with advantage. But the same solubility will cause its earlier removal from the land by rains and drainage, unless the precaution be taken of applying it at intervals, as we have suggested." See the articles FLOUR, STARCH, BREAD, GLUTEN, GRAIN, and STRAW.

Sinclair's Hortus Gramineus Woburnensis.—Loudon's Hortus Britannicus.—Host's Icones et Descriptiones Graminum Austriacorum.—Lawson's Agriculturist's Manual.—Catalogue of the Highland Society's Museum.—Parmentier's Traité sur La Culture des Grains.—Von Thaer's Principes Raisonnés d'Agriculture.—Low's Elements of Agriculture.—Buel's Farmer's Instructor.—Baxter's Library of Agriculture.—Brown's Treatise on Rural Affairs.—Transactions of the Bath and West of England Society.—Communications to the Board of Agriculture.—Marshall's County Reports.—Farmer's Magazine.—Quarterly Journal of Agriculture.—Transactions of the Highland Society.—Journal of the Royal Agricultural Society of England.—Useful Knowledge Society's Farmer's Series.—Arthur Young's Works.—Museum Rusticum.—Mill's Husbandry.—Dickson's Husbandry of the Ancients.—Magazine of Natural History.—Boussingault's Rural Economy.—Sir John Sinclair's General Report of Scotland.—Burroughs on the Cultivation of White Crops.—Blaikie on Mildew—Liebig's Chemistry of Agriculture.—Rev. Edwin Sidney's Blights of the Wheat.—Johnston's Lectures on Agricultural Chemistry.—Rham's Dictionary of the Farm.

WHEAT-FLY. Any one of several insects which feed on wheat. The chief is the *Cecidomyia tritici*, popularly called the wheat-fly par excellence, or the wheat-midge; another of some interest is the *Cecidomyia destructor*, popularly called the Hessian fly or the American wheat-midge; and a third is the *Chlorops pumilionis*,

which has never obtained any distinctive popular name. All these are dipterous insects or true flies; and the first and second belong to the tipula family, and the third to the musca family.

The genus *Cecidomyia* is an extensive group, and comprises nearly 30 British species. Their antennæ are slender, granose, as long as the head or longer, more or less necklace-shaped, comprising in the female 13 subovate joints, and furnished with short verticillated hairs; their eyes are entire, and either oval or round; their forehead is narrowed and prolonged in the manner of a rostrum; their wings are membranous, ciliated, pubescent, and incumbent on the body, and present each but three nervures; their palpi are long and four-jointed; and the extremity of their tibiæ is spinous. But though forming a perfectly natural and quite distinct group as to their structural character, they differ very widely from one another in habit and economy; for while two, as we have hinted, live upon the ears of wheat, some live on rotting tulip and hyacinth bulbs and on half-decayed cow-dung, others inhabit the leaves of the Scotch pine, the buds of the sallow, and the flower-buds of the common hedge-mustard; and many form downy excrescences, somewhat similar to galls, upon ground-ivy, field wormwood, common campion, and some other plants.

The wheat-midge, or British wheat-midge, or chief wheat-fly, *Cecidomyia tritici*, is very minute, scarcely exceeding the twelfth part of an inch in length, and resembling a small gnat or midge. The female has a pale ochreous colour and is pubescent. Her eyes are intensely black, and coarsely granulated, meeting on the crown, and covering nearly the whole head. No part of the mouth is visible, except a short bilobed pilose lip, and two incurved palpi or feelers, which are four-jointed and slightly pilose. The antennæ are stretched forward or curved upward, and inserted close together in front of the face; they are as long as the body, pale brown, and clothed with longish hairs; and they comprise thirteen sub-elliptical joints, contracted round the middle and connected at the ends by a single thread, like a string of beads. The thorax is ovate and of a deep reddish ochre colour. The scutellum is transverse-oval. The abdomen is rather short and tapering to the apex, which is furnished with an ovipositor nearly thrice as long as the body, the sheaths at the base stout, the oviduct exceedingly slender. The wings are incumbent in repose, longer than the body, yellowish-white, and beautifully iridescent, pubescent, and ciliated; the costal nervure surrounding the wing, the subcostal short, the second extending to the margin, the third shorter, the apex forked. The two halteres or poisers are large and capitate. The six legs are long, slender, and nearly of equal length. The thighs and shanks are equally long. The tarsi or feet are five-jointed, the basal-joint minute in all, the second as long as the tibiæ, the remainder decreasing in length. The claws are very minute. The male is seldom seen; and his antennæ are believed to be usually composed of twenty fine globose and somewhat remotely strung joints. The ovipositor of the female, notwithstanding its great length, is not seen, and would not be suspected by a stranger to exist in the ordinary condition of the fly; but is readily discovered by pressing the anus, or at the season of oviposition. It can be unsheathed by the insect at pleasure; and it comprises a long retractile tube or vagina, together with an aculeus, or pointed instrument like a sting, as fine as hair.

The wheat-midge makes its appearance in wheat-fields just about the time when the ear is beginning to emerge from its leafy envelope, most commonly in the early part of June. It readily escapes the observation of persons ignorant of its character, or not looking out for it; but, to an intelligent observer, it may be seen on calm evenings, most frequently about eight o'clock, swarming about in small undulating clouds, in the manner of winter gnats and other kindred species, and it is occasionally seen also in the mornings and during the day. Each female usually chooses as the receptacle of her eggs an ear just emerging from the sheath; and she introduces them by means of her ovipositor into the floret,—and while doing so, keeps her anus nearly at right angles with the margin of the floret's glume. She is so engrossed with her occupation that she is not easily disturbed, and may even go on with her proceedings though a magnifying glass should be held close to her by an observer; and she slowly introduces her ovipositor, and slowly parts with her eggs, and then cautiously and deliberately withdraws the instrument. So many as thirty-five flies may sometimes be seen at one time upon one ear; and some one or more of them may become almost exhausted in the effort to withdraw the ovipositor, or even may entirely fail to withdraw it, and remain fastened to the spot till devoured by some enemy. Mr. Kirby, after some vain attempts to see the eggs pass through the long retractile tube, eventually witnessed that curious phenomenon. "I gathered an ear upon which some of the insects were busy," says he, "and held it so as to let a sunbeam fall upon one of them, examining its operation under the three glasses of a pocket microscope. I could then very distinctly perceive the eggs passing one after another, like minute air-bubbles, through the vagina, the aculeus being wholly inserted into the floret. I examined the process for full ten minutes before the patient little animal disengaged itself; and at last it was through my violence that she discontinued her employment and flew away." The eggs, in passing through the oviduct, receive a coating of glutinous matter which causes them to adhere firmly to the glumes; and they are deposited in small clusters, varying in number from two to upwards

of twenty; and they amount in the aggregate to so vast a multitude as might seem to threaten terrible desolation or even utter destruction to wheat crops. They are oblong, transparent, and of a pale buff colour; and are hatched in the course of ten or fourteen days. The minute maggots which proceed from them have the same general form as other dipterous larvæ; and are at first transparent and colourless, but soon begin to assume hues of straw-colour, yellow, saffron, and orange, according to their age. They are thought by some persons to feed on the pollen, and by others to live on the juices of the ovary; and they not improbably devour the reproductive substances of both the anthers and the germen, both before and after the shedding of the pollen; but at all events they so completely destroy the reproductiveness of the particular florets in which they are lodged that the seed never forms and the parts of fructification lose all their virus and shrivel and decay. So many as forty-seven have been counted in one floret; and even the smallest number ever present seem to be perfectly competent to do the work of destruction. Nearly all become full-grown about the beginning of August; and they may then or a little earlier be easily found on examining an infested ear; and they afterwards either remain among the heads of the wheat, and continue ensconced there till they become transformed into pupæ, or leave the ear, and pass down to the ground, and bury themselves in the soil or about the roots of the stubble, there to await their transformation; and when the corn is thrashed, either the larvæ themselves enveloped in a singular kind of membrane, or the pupæ which have been formed from them, may be discovered in the chaff-dust, and if abundant and conspicuous, will readily be mistaken by unsuspecting farmers and farm-servants for the seeds of weeds. "Naturalists who have given their attention to these insects," says Mr. Sidney, "are of opinion that the chrysalis state is not reached till the spring, and that the thin membranous covering is a protection against cold till that condition is attained. It is true that there has been one instance of a fly hatched from a chrysalis in September, but this was an exception. There have been many attempts made to breed these flies from the larvæ covered with the membrane, or the supposed chrysalides found in the chaff; but all have failed. It was tried in vain by the writer; but he thought others might have obtained them by reason of more skilful methods, till on inquiry he found they were equally unsuccessful. Conjectures have, as usual, been sufficiently abundant; and a question has been raised, whether the larvæ do not enter the earth to become pupæ or chrysalides. Certain it is that the membranous cases of the larvæ are found left adhering to the sound grains and to the chaff-scales; and Professor Henslow and others assert, that some larvæ have been known to leave the ears and bury themselves in the earth. Any entomologist who decides the question whether these larvæ certainly enter the ground to turn into pupæ, will do great service to science in general, besides affording information to the farmer respecting the habits of one of the most fatal enemies to his produce when the season is suitable to them."

The ravages of the wheat-midge are somewhat fitful,—insignificant in one season and excessive in another,—inconsiderable on some farms or crops and very considerable in others; but, in the aggregate of years, they are much greater than most farmers are aware of or would readily believe. Mr. Kirby estimated the loss in a field of 15 acres which he particularly examined at about one-twentieth of the whole produce, or at an average of about two grains in each ear. Mr. Markwick, who in the first instance did not suppose the wheat-midge did any serious mischief, became eventually convinced that Mr. Kirby's estimate was not too high if applied to infested wheat-crops in general; for of the ears which he examined, scarcely any contained fewer than two injured grains, most contained more, and some contained so many as six. Mr. Gorrie estimated the loss in the late sown crops in Perthshire, in 1828, at one-third of the whole produce. Mr. Bell of Mid Lioch, writing in June 1830, expresses apprehensions respecting the crops of Scotland fully in accordance with Mr. Gorrie's estimate, and says, "Another year or two of the wheat-fly will make two-thirds of the farmers here bankrupts." Mr. Sidney says, "The author can assert that in the autumn of 1845, he found great quantities of the larvæ not only in a first-rate wheat district in Norfolk, but in other parts of the country. Ear after ear was gathered by him, examined, and the contents shown to farmers who never before had even heard of such things, and who were perfectly astonished when they saw them. Often has he also entered a barn and taken up a handful of dust from the floor where wheat has been winnowed, turned out the little orange-coloured devourers, now in their membranous cases, one after another, but scarcely ever met with any person who had previously noticed them. If they had seen them, they took them for the seeds of some kind of weed. There seems also to be good reason to suppose that the wheat-midge is to be found on the continent of Europe, and that it attacks the corn-crops in France, causing the same sterility in the grains that has been shown to be the result of its ravages in England."

The wheat-midge is known to subsist on common couch grass, *Triticum repens* or *Agropyrum repens*, in the same manner in which it subsists on wheat; and it might therefore be supposed to attack with equal readiness all plants more nearly allied to wheat, and particularly all the species and varieties of wheat itself; yet it is generally believed to have strong preferences and dislikes in refer-

ence to the commonly cultivated wheats, and has been supposed or observed to do prime injury to some, secondary injury to others, and little injury or none to others. One reason why some wheats are little affected by it may be that they are generally sown at a time which, conjointly with their habits, occasions their coming into ear at a period when the midge is not in a condition to attack them; and another reason why the same or other varieties enjoy comparative safety may be that they have too hard an envelope to be readily pierced by the midge's ovipositor. "The species of woolly-eared, Lammas red, and Rivet wheats," says Mr. Shirreff, "have been stated in East Lothian to resist the attack of the fly. The two first mentioned kinds come into ear about a week sooner, the last about a week later, than those commonly cultivated, and to these peculiarities owe their occasional escape, earing either before or after the general depositing of eggs takes place. The fly, however, does not always appear in strict conformity with the growth of the wheat plant, and the earing of different species is late or early, compared with the general crop, according to the time at which they are sown. The eggs of the wheat-fly are generally deposited when the ear is escaping from the sheath,—and when delayed beyond this period, the grains either become diminutive, or the maggots perish; and therefore a species of wheat in some measure impervious to the ovipositor of the fly at this stage of the plant's growth must tend to mitigate the ravages of the fly. There is such a species cultivated in many countries, the name of which is the Polish wheat, *Triticum polonicum*. It is characterized by a large exterior chaff, which closely envelopes the cups when the ear is escaping from the sheath, and at this time defends the flower in a great measure from the fly's ovipositor. I have grown the polonicum, on a small scale, amongst other kinds; and although it did not altogether escape the attack of the fly, it was much less injured than any of those which came into ear at the same time." The *Triticum polonicum*, however, is very far from being eminent in other good agricultural properties; and, if really proof against the midge, it probably could not render better service to farmers than by being made to communicate its large exterior chaff to some of the best cultivated varieties through the process of hybridizement. A variety called in some parts of England cone wheat, and known in some parts of Scotland as antifly or cone Rivet or German thickset wheat, belonging to the species *Triticum turgidum*, and somewhat nearly akin to the common Rivet and Pole Rivet wheats, possessing a tall vigorous stem, and yielding a very large produce, though the grains are coarse and of inferior quality to those of the common winter wheat, was found by Mr. Gorrie, in the course of comparative experiments during the prevalence of the wheat-midge in 1829, to be completely proof against the midge. "I had a fall of it," says he, "growing in the centre of a field of common wheat, which came in the ear on the 22d June, exactly at the same time with the common variety. At that period, I visited the field every evening for a week, and although the flies were numerously and busily employed on every ear of the common wheat, the half of which they destroyed, I, and my friends, who went frequently with me, could only detect one solitary fly at work on the new variety; and although the ear was marked, no maggots could therein be afterwards observed." The field of 15 acres examined by Mr. Kirby was planted partly with common white wheat and partly with common red; and the result of his examination was that in thirty ears of the white, seventy-three grains were destroyed by the fly, being at the rate of not quite $2\frac{1}{2}$ grains per ear, while in twenty ears of the red twenty-nine grains were destroyed, being at the rate of not quite $1\frac{1}{2}$ grain per ear. But all these instances, as well as some others which have been recorded, are probably more or less deceptive; and the different results may have been in an appreciable measure due either to the accidental circumstance of one crop being more exactly in the stage of fitness for the insect's use than another, or to the influence of the gregarious habits of the midge, whose swarms usually assemble and remain in the neighbourhood of the spot where it first finds a nidus or is induced to make a settlement; and even in periods and districts which have become signalized by great and recent ravages of the midge, many an intelligent farmer may perhaps think himself less safe in trusting to the reputed antifly properties of any particular variety, than in aiming to bring wheat crops of the best common agricultural varieties into developement a little before or after the time when the fly is likely to be most active in the work of depositing its eggs. Yet though this device might seem to be obvious and efficient, and though it has been recommended as a preventive by very distinguished practical agriculturists, it may often be baffled either by the retarding or accelerating of unusual weather upon the crops, or by the sustaining and modifying influence of unusual circumstances upon the fly. "The designs of Nature," remarks Mr. Duncan, "are not to be thus easily frustrated. There is a plastic and accommodating principle in the nature of insects, conferred upon them by that Benevolence which careth for all its creatures, apparently for the express purpose of enabling them to maintain their existence among the numerous hostile influences to which they are continually exposed. In such a case as that here supposed—the female being ready to deposit her eggs before the appropriate plant is ready to receive them—it usually happens that the life of the insect is purposely prolonged until a suitable opportunity occur for continuing the species. A whole season is in this way sometimes added to the ordinary duration of insect

life; and it is unlikely, unless in rare cases, that the brood is ever lost in consequence of a want of synchronism in the maturity of the insect and the plant which is to form the nursery for its young." Still, though the whole brood may never be cut off by anachronism between the plant and the insect, the numbers of it may thereby be very materially diminished; and though a farmer, in any infested district, or after any disastrous season, ought never to rely solely or mainly upon the producing of such an anachronism as a preventive, he may at least regard it as an auxiliary of sufficient possible consequence to be worthy of his attention.

Remedies or preventives directed immediately against the life or operations of the perfect fly were recommended by Kirby as most likely to prove successful. "By a set of experiments first made upon a small scale," says he, "the intelligent farmer may possibly find out some method that will prevent this insect from laying its eggs in his wheat. These should commence as soon as the ear begins to quit the *folium vaginans* or hose; and they ought to be continued till the germen is impregnated, or, to use the rural phrase, the wheat is off the blossom. Perhaps fumigations of tobacco or sulphur, if made when the wind is favourable, might render the ear disagreeable to this insect." But either fumigations of any such kind, or medicated aspersions, or any other applications which might be suggested, in order to be made on a sufficiently extensive scale to produce decided effect, would probably cost almost as much trouble and expense as they could be worth, and might also deteriorate the market value of the wheat or even impart to it deleterious properties. Remedies or preventives directed against the matured larvæ or the pupæ have been suggested by some distinguished savans on the assumption that they burrow in the ground, and by others on the assumption that they principally or wholly continue attached to the harvested corn. "It is possible," says Mr. Duncan, "that Mr. Gorrie's plan of ploughing the wheat stubbles, and having what is called a skim-coulter attached, of such a construction as would cut and lay about an inch of the surface at the bottom of the furrow, would bury many of the pupæ at such a depth as to render their resurrection improbable. But grass and clover seeds are so often sown with wheat, that this method can seldom be practised, even if there was more inducement to follow it than there really is, without deviating from the ordinary rotation. The same objection will apply to Mr. Poppy's suggestion of burning the wheat stubble on the land; but when this can be done, it promises to be a highly useful expedient. When the stubble is short and scanty, the conflagration may be assisted by straw, or other inflammable matters, (such as dry furze,) brought for the purpose. If it is rank, as is usually the case in Suffolk and some other southern counties where the reapers scarcely bend their backs in cutting the crop, the fire will be sufficient to heat the whole surface of the ground, and in all probability will destroy the greater part if not the whole of the pupæ, heat being speedily fatal to them." But the probability is that a large proportion of the larvæ which live to become pupæ remain attached to the harvested corn till separated from it by the process of thrashing, and that they are afterwards conveyed, in mixture with the chaff-dust, either directly or indirectly to the ground, and there pass in spring or in early summer into their pupa state; so that a method of prevention recommended by Professor Henslow, for separating the chaff-dust and afterwards carefully collecting and burning it, may be by far the most efficient of all the methods hitherto proposed, and certainly is the cheapest and easiest. He says, "It occurred to me that, if a wire-gauze sieve were placed before the winnowing-machine in a sloping position, so as to allow the chaff to fall upon it and then roll from it, the pupæ would pass through, and might be caught with the dust in a tray placed below the sieve. I have put this to the test of experiment, and find it answer perfectly. Two pieces of wire-gauze were placed together at an angle, sloping like the roof of a house, and the chaff readily fell off on each side to the floor, while dust and pupæ passed through. If a simple contrivance of this kind formed an appendage to every winnowing-machine in the country, what myriads on myriads of the pupæ might be collected and destroyed!"

Some natural enemies of the wheat-midge, however, keep it powerfully in check; and, in particular, three species of ichneumons, "minute benefactors of our race, sent in mercy by Heaven, know how to introduce their eggs into its larvæ, thus preventing the mischief they would otherwise occasion, and saving mankind from the horrors of famine." One of these ichneumons, *Encyrtus inserens*, is black and shining, and about half the length of the wheat-midge; another, *Eurytoma penetrans*, is black, with a brassy lustre, the abdomen glossed with blue, compressed, and truncated behind; and the third and most important, *Platygaster tipulæ*, is a minute black midge-like fly, with the legs and the base of the antennæ red,—the male quite black, and rarely seen,—the female of a pitchy colour, with a sharp ovipositorial point at her tail, exceedingly abundant and active in all infested fields in the months of July and August. "Superficial observers who have noticed the larvæ of the wheat-midge in the ears," remarks Mr. Sidney with particular reference to the *Platygaster tipulæ*, "have mistaken the ichneumon, which they have observed amongst them, for the parent of these larvæ, and have consequently condemned it as the origin of the very ills it is destined to diminish. This affords another instance of the folly of hasty conclusions, and of the false

reasoning relative to the inferences people deduce without accurate investigation, when they merely see two things together. Just in the same way some farmers have concluded that the little ichneumon flies we are now noticing must lay the eggs producing the larvæ of the midge, because they have themselves seen them amongst the corn containing these larvæ. It is time for all observers to arrive at a better state of knowledge, lest we destroy, as authors of mischiefs, the friendly antidotes to their increase. Prejudice and hasty judgment lead to perpetual misconstructions as to things both moral and natural. But to return to the ichneumon. This little platygaster may be readily found on the glumes of the wheat-plants, in the months of July and August. It runs rapidly over the ears, and seems to know well which are those occupied by the larvæ of the midge. The author found numbers of them in various wheat-fields in August, 1845; and almost invariably, on examining the ears on which they appeared, discovered that they contained the objects of their search. The ichneumon hunts for them with the utmost eagerness, and by the aid of a sharp tail places a single egg in each of their bodies. The sight has been witnessed by the following experiment: a number of larvæ of the wheat-midge were put upon a piece of white paper, pretty near each other, and an ichneumon was dropped into the midst of the group. The energy of her manner, the rapid vibrations of her antennæ, and the whole of her attitudes, were most amusing. On approaching one of the larvæ, her agitation quickened to the utmost intensity; she soon bent her body in a slanting direction beneath her breast, applied her tail to the larvæ, and, becoming still as death, sent forth her curious sheath and deposited her egg in the victim, which writhed considerably under the operation. If she came to one that had previously an egg in it, she left it in an instant and sought another; for the platygaster lays but one in each. This, however, often repeated, destroys a great many of these little devastators of the grain. The observations of Professor Henslow confirm those which have been already made. He says, 'When these eggs are hatched, the young maggots which they produce, and which are the caterpillars of the ichneumons, feed upon the fleshy or muscular parts of the caterpillar they are attacking, carefully avoiding the vital parts. At length the caterpillar they have been thus devouring alive dies; or, as frequently happens, it changes to the state of a chrysalis before it is destroyed. The ichneumon caterpillars also pass to the chrysalis state, and either remain within the body of the dead caterpillar, or come out before they assume the fly state. Each species of ichneumon is restricted in its attacks to one or at most to a few particular species of caterpillar; and the females instinctively proportion the number of eggs they deposit in each individual to the relative size of their own offspring and that of the insect on which they are destined to prey.' It is impossible to contemplate these habits of the minute insects thus brought before our notice, without being deeply impressed with the omnipresence of the great Being to whom all things owe their existence. The same hand that spread the north over the empty space, and suspended the earth upon nothing, and keeps the stars in their courses, regulates the numbers, instincts, and uses of the smallest living things, appearing equally perfect in all:

> 'What less than wonders from the Wonderful,
> What less than miracles from God can flow?'"

The American wheat-midge or Hessian fly, *Cecidomyia destructor*, works great havoc in America, and has of late years become known in various parts of Continental Europe, but does not seem to have ever been detected in Britain. Yet it deserves somewhat particular notice, at once as an object of general curiosity to agriculturists, and on account of its congenership to the British wheat-midge, and for sake of the possibility of its yet becoming practically and painfully known to the British farmer. "The Americans," says Mr. Curtis, "entertain an idea that this fly was first introduced into their country in straw which accompanied the Hessian troops; whence they have given it the appellation of Hessian fly. It has been occasionally a dreadful scourge in North America, for the larvæ have committed such ravages on the wheat-crops as to cause even famine in the land. It was not until the autumn of 1833 that this destructive insect, or a species closely allied to it, was observed in Hungary; whether, from its previous rarity, it had been overlooked, or had not found its way into the Austrian dominions, is not known. Kollar states that it appears, from a report transmitted to the Archduke Charles, that in the beginning of June the ears of wheat were observed to droop and the straw to bend, on his estates at Altenburgh, although the crop was previously in fine condition: in a few days, patches on the poorest soil in different parts became entangled, as if matted together by heavy rains or high winds, which were supposed at first actually to have been the cause. This soon proved to be unfounded; for the mischief gradually spread from the poor to the best lands, until the whole was blighted. Two-thirds of the straw at least was laid in less than a week, and the work of devastation was completed by the heavy fall of rain which took place during the latter part of June. The straw thus prostrated produced only small abortive ears; the few grains they contained were shrivelled, and would scarcely ripen, and the straw was of a very bad quality. On examining the roots of those plants which had died off, the soft straw where the larvæ had stationed themselves in families, within the sheath of the leaf, ap-

peared withered, tough, and brown, yet not wounded: at this period the larvæ were transformed into pupæ, which were found in clusters inside of each leaf-sheath, at the first joint next to the crown of the root. On the estates of the Duke of Saxe Coburg, at Weikendorf and in other parts of that neighbourhood, whole fields were destroyed. The larvæ were found to live in society, forming a sort of nest between the straw and the sheath. They are said to penetrate into the tube of the straw: however that may be, they deprive the stem of the sap, and it consequently withers and dies. The larvæ are of a pale green colour, with a minute black dot above; they do not exceed two lines in length; and they live from about three weeks to a month: the pupa is brown, and enclosed in a case. It was several weeks before the fly hatched; it is extremely small and delicate, scarcely so large as a common gnat; the body is clothed with short black hairs; the thorax is very convex, smooth, and shining; the scutellum projects, and is rounded behind; the breast being sometimes of a golden yellow colour, the abdomen brownish; the wings are blackish; the deep yellow of the base sometimes extends to the nervures, where it is gradually softened off: the poisers are yellowish white; the base of the thighs is golden yellow. The female has a black streak on the abdomen. The above descriptions do not agree with Say's; and I see, by a paragraph in the Entymological Transactions, Mr. Herrick, of New Haven, North America, had informed Mr. Spence that the accounts hitherto published concerning the natural history of the Hessian fly were very erroneous: he considered it to be referable to Meigen's genus *Lasioptera;* and it is attacked by five parasites, two of which belonged to the genera *Eurytoma* and *Platygaster*. Mr. Spence also observed, at a previous meeting of the Entomological Society, that Dr. Hammerschmidt's *Cecidomyia*, which is the Hungarian one, is specifically distinct from Mr. Kirby's *C. tritici;* and that Say's *C. destructor*, called the Hessian fly, is different from either. The female of the American species lays in the autumn not more than eight eggs, which are introduced by her ovipositor between the sheath and the stem, close to the base, where the larvæ feed as soon as they hatch, and are said to live through the winter with their heads downward; but the mischief they cause is not discoverable until the wheat is more advanced. A parasite, called by Mr. Say *Ceraphron destructor*, but which may possibly be a *Pteromelas* in the opinion of Mr. Westwood, though smaller than the *Cecidomyia*, proves so formidable an enemy, by depositing its eggs in the larvæ, that few of them become pupæ; otherwise, Mr. Say believes that their wheat-crops would be totally annihilated. Kollar also found the majority of his pupæ so full of a similar parasite that he felt convinced the crops would not be attacked by the wheat-midge the following year; which prediction was completely verified."

The *Chlorops pumilionis* injures the young stem or central shoot of the wheat plant after it has risen a considerable way above the ground. The genus to which it belongs comprises upwards of twenty British species, which may often be observed in great numbers on umbelliferous plants, and not rarely in houses, during the months of autumn; and it is characterised by the face being naked, the forehead tomentose, the seta of the antennæ distinctly two-jointed, the abdomen oval, the feet naked, the costal nerve of the wing extending to the tip of the submarginal, and the prevailing colour, in most cases, being brown with various stripes and spots of bright yellow. The wheat-fly species bears the name of *pumilionis* or 'dwarfish,' in consequence of its dwarfing the wheat-plants which it attacks, destroying their proper stems, and causing them to throw out many lateral shoots which seldom attain any considerable height. Its predominant colour is black; the under side of the head and two longitudinal lines on the thorax are yellow; the under side of the body is pale yellow, with two black spots on the mesosternum; the halteres are white; the legs are ash-grey with black tips. The maggot is small and white, the body composed of eleven well-defined rings, the head pointed at the end, black at the tip, and resembling the letter V in shape. The pupa is yellow, smooth, and shining, and rather more than the twelfth part of an inch in length. The *Chlorops pumilionis* caused great alarm in Britain about 50 or 60 years ago, in consequence of being mistaken for the American wheat-midge; and it was first noticed in a scientific way, about that time, by Bjercander in Sweden and by Mr. Markwick in Britain. It attacks rye much more frequently than wheat in Sweden and other northern countries. Bjercander did not succeed in observing it deposit its eggs; but he found its larvæ in great plenty from the 23d of April till nearly the end of May, when they became for the most part fully grown. He could not discover any holes in the stems of the plants; and he thence inferred that the eggs or larvæ must enter at the top of the leaves, and that the fly when matured forces its way upwards and escapes. Mr. Markwick found the larvæ lodged in the centre of the stem of wheat plants just above the root; and he observed that, by the end of March, many of them were full grown and passing into the state of pupæ. He did not see the deposition of the eggs any more than Bjercander; and he indulges in some conjectures as to the manner in which they had been introduced into the field, concluding that it could not well be by means of the manure, as that consisted entirely of lime. What we know of the proceedings of other insects, in similar cases, leaves little room to doubt that the eggs were placed on the plant by the fly itself. "The larva and chry-

salis," says Mr. Markwick, "were always found deposited on the principal stem, just above the root. This stem it invariably destroyed, which gave the crop a most disastrous appearance, so that there was scarcely a hope of any produce; but after the larva had changed into a chrysalis state, the mischief ceased, and the root was not so materially injured as to prevent its throwing out fresh shoots on each side, and stocking itself, as the farmers term it, as I experienced by those I planted in my garden." Bjercander recommends that the infested stems should be pulled up and burned while the insect is yet in the larva or pupa state; but as the plant makes such vigorous efforts to recover itself, and even at times succeeds in bringing ears to maturity, it seems preferable, as Mr. Markwick advises, to pinch the central leaves just above the crown of the root, which would probably destroy the insect without materially affecting the vitality of the plant. It was found that it was only the early sown wheat that was attacked, such fields as were sown later than the middle of October escaping without injury.

WHEAT-GRASS. See WHEAT.

WHEAT-MIDGE. See WHEAT-FLY.

WHEAT-RIDDLE. See RIDDLE.

WHEEL. See WHEEL-CARRIAGE, CART, and WAGGON.

WHEEL-BARROW. See BARROW.

WHEEL-CARRIAGE. The principal wheel-carriages used in British agriculture are noticed in the articles CART, WAGGON, and LIQUID MANURE CART; and some important topics connected with them are discussed in the articles FRICTION, SPRING, DRAUGHT, ROAD, and HORSE. We shall, in this place, make ample extracts, with some slight alterations, from an able essay on agricultural wheel-carriages by the distinguished mathematician William Galbraith, in the 2d and 4th Volumes of the Quarterly Journal of Agriculture.

Wheel-carriages are generally divided into two kinds or classes—one having two wheels, and the other four; and both these have their peculiar advantages. For lighter purposes, those having two wheels are generally employed. They are more readily managed, quicker in their movements, and relatively perform a greater quantity of work with the same number of horses than the larger machines; while for the transportation of the more bulky and ponderous objects, those having four wheels are most convenient, and often absolutely necessary. The bodies of the carriages which are intended to contain the load supported upon the wheels, are, or ought to be, formed according to the species of loads they are likely to carry. When the loads are specifically light, the body should be large and full, so as to bring the centre of gravity as low as possible, to prevent the cart from overturning on an inclined road, when highly loaded with comparatively light materials, as hay, straw, and similar substances. For loads of great specific gravity in particular, that is, loads of considerable weight within a small bulk, the body of the carriage should be strong and compact, and every advantage taken of the materials of which it is constructed, to render it sufficiently strong, with the least possible weight, by means of a proper arrangement of its parts to resist pressure without derangement or fracture. This can only be accomplished by possessing an accurate knowledge of the relative strains in different parts, and then applying the iron, wood, and other materials, in the best possible manner, founded upon scientific principles. In the common cart, for example, with two wheels, since the shafts must support generally the most considerable strain in a vertical direction, they should therefore be stronger that way than in a horizontal direction; or a section of each shaft somewhat rounded in an elliptical or parabolic shape, should have its greatest diameter in a vertical position. This is obvious from the well known property of beams demonstrated by Galileo, that their strength is proportional to the breadth multiplied by the square of the depth. Whence the relative strength of two beams of the elliptical or parabolic form, supposing the area of the section to be the same, is as the longer diameter to the shorter. This shows the great importance of giving every part not only its proper size, but also its true position. No doubt sometimes in turning a cart, there is an additional strain on the shafts in a horizontal direction, though far from being sufficient to justify such a deviation from sound principles.

The axle ought to be properly and securely fixed to the body of the carriage, by bolts, hoops, or such other means as may seem most convenient. To give the wheel the best position for easy motion, and as little friction as possible, the general shape of the axle should be straight. Its arms should be rounded, slightly tapering, in the form of a frustrum of a cone, and smallest at the extremities, that it may not wear loose; and at the same time that it may allow the wheel to be readily removed and replaced without being too tight, or having too much play, though sufficient to admit the usual compositions of tar, grease, &c., to lubricate the axle and diminish friction. As every body is liable to bend by pressure, it is obvious that the axle, whether made of wood or iron, will be liable to flexure in a slight degree, in a vertical direction. Since the force of the power applied to move the carriage forward will be opposed by the friction of the wheels upon the irregularities of the road, there will also be a slight tendency of the axle to bend backwards at the extremities. These two flexures, however, from the nature and construction of the machine, must be very slight: and therefore a very small bend downwards and forwards given to the extremities of the axle, will be sufficient to counteract these effects, and render the lower surface of the arms of the axle nearly horizontal within the naves of the wheels.

Great care should be taken not to give the axle at its entrance into the nave of the wheel too great a bend, as is sometimes customary, particularly in England. The bad effects of this are, to cause the wheels to be formed somewhat of the shape of the frustrum of a cone, of which the vertex is at some distance from the carriage, nearly in the direction of the axle, whereby the wheel, instead of proceeding forward, naturally has a tendency to move round the imaginary vertex of the cone just alluded to, as a centre, revolving obliquely, producing an irregular and unfavourable action of the parts in contact, and increasing friction. It is likely, indeed, that the axle in the rude machines of early ages was at first straight, but as improvements were introduced, it would in time receive such modifications as the judgment or caprice of the constructor might suggest. Still, however, there seems to be no just objection to the axle being nearly straight, in order to insure the best and easiest motion to the wheels, provided the part within the nave be truly cylindrical and of equal diameter throughout, though

there may be some other advantages attending a deviation from this form, which will be afterwards examined. Thus A B, *Fig.* 1, would likely be among the more early modes of constructing the axle, having shoulders at C and D, and iron bars called *linch-pins* at E and F, to keep the wheels G H and I K (having their planes perpendicular to their axis, and rendering their motion of rotation by that means the easiest possible), steady in their proper position; the parts E C and D F, round which they revolve, being equal cylinders of the same diameter. In this mode, however, it would be found from experience, that the wheels would with difficulty, or at least less easily, be removed and replaced, more especially before the invention of a machine for raising the wheel from the ground, as is now usual, at least for gentlemen's carriages. This would suggest the propriety of giving the axle a slight taper towards its axis at the extremities, in order to remove the inconvenience. At the same time, the wheel may be prevented from becoming loose by wearing, by pressing the nave towards the shoulder, and tightening it by the linch-pin. The axle would then have the shape of *a b*, *Fig.* 2, tapering all around regularly from *c* to *a*, and from *d* to *b*, and the planes of the wheels *gh*, *ik*, would still be at right angles to the axis, rendering their circular motion the most favourable for ease and simplicity. One bad property would result from this structure, namely a tendency of the wheels to slide off at the end of each axle, thus producing a considerable pressure on the linch-pins, at *e* and *f*, which would be both inconvenient and injurious, from the severe friction of the bushes in the naves against them. The upper parts of the wheels would, in both the preceding methods, be liable to rub or chafe the carriage, or the load when it projected over the sides of the cart; while in wet weather the mud carried up by them would partly be thrown into the cart, and would partly fall upon the axle and nave, and work in between the axle and bush, causing a considerable wear in both in a short time.

Fig. 1.

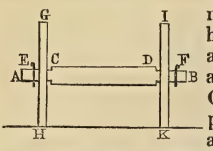
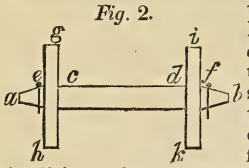
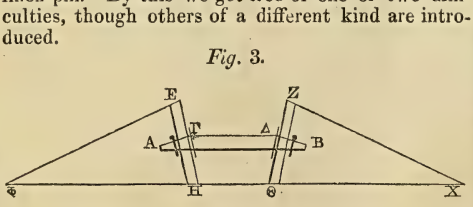


Fig. 2.



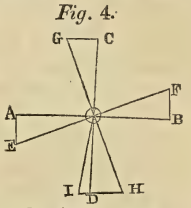
To obviate these inconveniences, it would next be requisite to render the lower surface of the tapering and working part of the axle called the arm perfectly, or at least nearly, horizontal, so that the pressure on it should have no tendency to force off the wheel, and make it press unnecessarily on the linch-pins, while the upper parts of the wheels by this means would be thrown outwards from the load, and would move quite free of it. Indeed, it seems to be sanctioned by experience, that the axle should be slightly bent at the shoulder, in order to give the wheel a tendency to press upon the axle rather than on the linch-pin. By this we get free of one or two difficulties, though others of a different kind are introduced.

Fig. 3.



Let AB, *Fig.* 3, be the axle, having its under side nearly a straight line, the extremities ΓA, ΔB, tapering within the naves; then the planes of the wheels become oblique to the horizon: the exterior surface of the felloes must be bevelled so as to become a small frustrum of a cone, the vertices of which are about Φ and X, thus introducing oblique action in motion, and an unfavourable position of the spokes of the wheels, with regard to strength, since they must be strongest when perpendicular to the level plane ΦHΘX. This last evil may be corrected by *dishing* the wheels, as it is called, while the oblique motion of the wheels arising from their necessarily conical shape, produces less injury in ordinary circumstances than that derived from the pressure of the nave against the linch-pins in equally tapering axles. Hence, if the under surface of the axle be straight, the quantity or amount of the dishing ought to depend upon the angle of taper of the axle, the one being exactly equal to the other. For let AB, *Fig.* 4, be a horizontal line, and CD a vertical line at right angles to it. Also, let EF be a part of the axis, or central line of the tapering axle, and GH a perpendicular to it, passing through O as before. Then the angles AOD, EOH are right angles. From each take away the common angle EOD, and there remains the angle AOE equal to DOH; that is, to bring the under part OH of the oblique wheel GH into the vertical position OD, it must decline from the plane of the oblique wheel GH at an angle of *dishing* HOD, equal to AOE, which the oblique central line of the axle makes with the horizontal line AB. If this principle be attended to, the spokes will, on a road nearly level, be truly vertical, or in the strongest position, as in this situation they ought to be.

Fig. 4.



In the case of iron axles, the taper is in general small, and perhaps would not, in many cases, be sufficient for the required quantity of dishing, which should be about one-twelfth of the diameter of the wheel; whence this easy practical rule,—the diameter of the wheel in feet gives the dishing in inches. Then a moderate bend in the axle will be requisite to bring them nearly to an equality, though the dishing should be properly a little more, not exceeding an inch or two, taking the direction OI; so that, when the carriage is inclined in a small degree, the under spokes are truly vertical. On these principles, let $\alpha\varrho$, *Fig.* 5, be the central line or axis of the cylindrical portion of the axle within the naves, to which $\varkappa\lambda$ is perpendicular, similarly to EH, *Fig.* 3, and $\varrho\eta$ perpendicular to the under surface of the axle; then, as has just been demonstrated in last article,

Fig. 5.

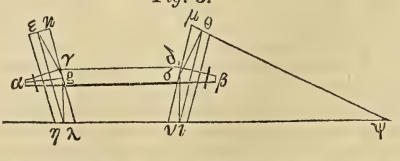
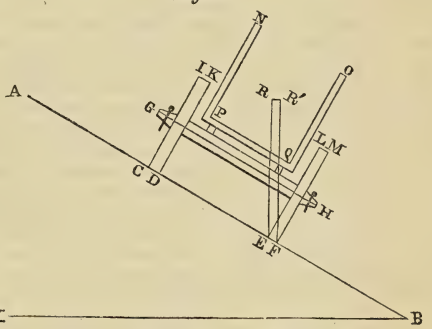


Fig. 4, it is obvious, that the angle $\eta\varrho\lambda$ is equal to the inclination of $\alpha\varrho$ to the sole of the axle. The taper consequently ought to regulate the amount of the dishing when properly executed, so that the spokes, in ordinary circumstances, may be nearly perpendicular to the plane of the road. Whence $\varepsilon\varrho\eta$ and $\theta\sigma\iota$ give the dished shape of the wheels; and, to make the dishing moderate, the taper of the extremities of the axle, combined with the bend, should not, taken together, be great. Hence also the stability of the carriage is not injured by this mode of dishing, because the centre of gravity is in as favourable a situation as if the wheels were actually vertical, since the spokes in the under part of the wheels are nearly vertical, however different the distance between the

felloes of the wheels may be at top and bottom, while the greater distance at the top gives additional room for both carriage and load. In fact, it is to the want of a proper attention to the nature and true properties of the axle, that most, if not all, the faults said to attend well constructed dished wheels may be attributed. Undoubtedly the oblique action of conical wheels is unfavourable for easy motion; but, if the spokes in the under side of the wheels be at right angles to the truly horizontal under surface of the axle within the nave, the easy motion of the wheel would not be much injured by such a shape, if it were possible that the exterior surface of the iron-hoop could touch the rod at the lower point only. Now as this, though not perfectly true in bad roads, is nearly so in good ones, there seems to be little cause for the vituperation of dished wheels properly made, which has been generally cast upon them by many popular writers, who have not investigated their properties upon scientific principles. Indeed they offer several advantages which the other wheels do not, and a careful consideration of their properties can alone show their qualities. Any custom very generally adopted, frequently results from some valid reason of the inventor, which is often lost sight of by his successors, who continue, as they think, to follow the original plan, sometimes with improvements; but having become ignorant of the motives and principles of the first constructors which should have guided them, they fall frequently into extremes, which are really injurious. In addition to the taper of the axle, a considerable bend, much more than is requisite for the purposes already pointed out, and consequently injudicious, is often given to it at the shoulder where it enters the nave, thus producing a very injurious action in the wheel, placing the spokes, or rather the plane of the spokes, too much in an inclined position towards each other at the bottom, unfavourable to strength, and diminishing the stability when the carriage is inclined on a bad road. All these ought to be particularly guarded against, although perhaps a slight degree of dishing more than the taper of the axle, depending on the amount of bend, may be given, especially when the wheels are narrow, as a slight inclination of the spokes *outwards* appears to be of use in keeping them more steady on their axles than if they were exactly vertical. By an inclination of the carriage, too, a greater proportion of the weight of the load is thrown on the lower wheel, and then its spokes, being in a vertical position, are able to exert all their strength with advantage. The dished form will be found on experience to render the wheels more lasting, because, from their slightly conical shape, the effect of the felloes, supported by the iron hoop, tends to bind them together, and prevents the spokes from working loose in the mortises of the naves. But when the spokes, as sometimes recommended, are at right angles to the axis, this property is lost, and the spokes are then chiefly prevented from working in the direction of the axis by the support of the nave only, and in time acquire a slight dishing in the opposite direction, or toward the cart, at the same time the tops of the wheels become closer than the bottom, which makes them look very unseemly. In some wheels each alternate spoke is made to have a different inclination, producing by that means greater stiffness and mutual support, by bearing against each other, and acting as braces in the direction of the axis, than when they have all the same degree of dishing.

The next property to be considered is the stability of wheel carriages, or their tendency to resist oversetting when on an inclined road, and moving at a considerable velocity. This depends upon the position of the centre of gravity of the carriage and load together. The lower it is, so much the more stable will the carriage be. A proper proportion between the height and breadth regulates this point. When carriages are narrow and high, the centre of gravity rises; and, on the contrary, when they are broad and low, under the same capacity, it descends; and a just proportion between these serves to assign its true and safe position, so as to fall within the wheels, even when the carriage is moderately inclined. It is obvious, then, that it depends in part on the proper position of the under part of the wheels, when the distance of their centres is given. By increasing the distance between the felloes at the bottom, the stability may be increased; and, by diminishing it, the stability will be lessened. But it is clear that a certain latitude only can be given to this variation of the inclination of the planes of the wheels, otherwise their strength and efficiency will be injured; and we shall now endeavour to place the different varieties in one point of view, so that the relative properties with regard to stability also may become known. Let *Fig.* 6 be a

Fig. 6.



carriage supported on wheels, of which the spokes are perpendicular to the axis of the nave, as in *Figs.* 1 and 4, formerly given, and moving on the inclined plane AB. *Fig.* 7, also corresponding to *Fig.* 5, and *Fig.* 8 to *Fig.* 3, already explained, and moving on

Fig. 7.

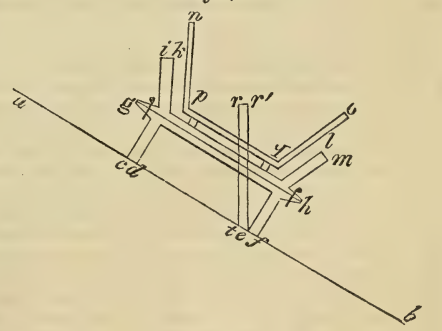
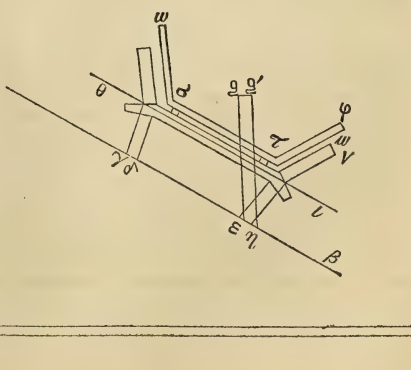


Fig. 8.



planes *a b*, *α β*, equally inclined to the horizontal or level line as AB to BX, *Fig.* 6. Also let the points marking the centres of gravity of these carriages be respectively R, *r*, *ϱ*, of which R is the highest above the road, from the smaller breadth of the body of the cart NPQO, which, from the shape of the wheels, cannot be wider at NO than at PQ. It is clear, from *Fig.* 6, that when the carriage is at rest, or moving straight forward, it is just stable, though very little more inclination would overset it, either by the wheel DI moving over any slightly higher obstacle, or by the wheel EM falling into a hollow. On account of the greater breadth at the top of the cart *n p q o*, *Fig.* 7, than that of NPQO, *Fig.* 6, the centre of gravity falls lower than R, and consequently the vertical line *rt*, passing through the centre of gravity *r*, falls nearer the middle between the wheels than RE. By reason of the bend in the axle of the cart, *Fig.* 8, which is, in this instance, too great, the soles of the wheels approach each other much more closely than either of the other two; and the vertical line ϱ^2, passing through the centre of gravity ϱ, falls nearly upon the bottom of the wheel, though, on account of the shape of the body of the cart, it is lower than either of the other two. Upon the whole, then, the construction of the cart or waggon, *Fig.* 7, with properly dished wheels on the plan formerly proposed, has still the advantage.—In addition to these, other means have been resorted to for the purpose of keeping the centre of gravity down. One of them consists in having the luggage placed as low as possible in travelling coaches, by carrying it in a box slung under the carriage, so as just to clear the road sufficiently. Such are the plans of some of our best coachmakers and agricultural implement makers.

It has as yet been supposed that the carriages were either at rest or moving forward in a straight line. It frequently happens, however, that, in the old roads in particular, a rapid turn, or quick bend, is met with in the road, where the carriage must turn smartly, producing what is called a centrifugal force, which has a tendency to throw the carriage over in the opposite direction, or towards the convex side of the turn. The amount of this force depends upon the radius of the curve in the road, combined with the velocity, which, in the case of the mail coaches, and travelling carriages, may sometimes be considerable. If this concur to augment the danger from the inclination of the road and a badly constructed carriage, on entering a bridge, or approaching a precipice in particular, the consequences may be fatal. Indeed, it is generally under these circumstances that the greatest accidents happen; whence a due attention to the proper formation of our roads is as indispensable for the safety of travellers, as an eligible construction of our carriages. To illustrate this to persons not very conversant with mathematical and philosophical inquiries, a few results, stated in a table, with conclusions drawn from them, will, it is hoped, be sufficient. The formulæ for obtaining the amount of centrifugal force are,

$$F = \frac{v^2}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

which gives the effects in feet, supposing the force of gravity, generally denoted by *g*, to be 32 feet; *v* the velocity of the moving body, or the number of feet which it passes over in one second of time; *r* the radius of the circle in which the body is moving, which, in this case, is the radius of the curve in the road; and F the centrifugal force. If the centrifugal force be required in terms of the weight of the moving body, then

$$f = \frac{v^2}{gr} = \frac{v^2}{32r} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

f being the value of the force, *v* the velocity, and *r* the radius of curvature, as before. Suppose the radius, or *r*, to be 100 feet, which is not an uncommon case, then will the following table, drawn up for the purpose, give the effects to different velocities:—

Velocity in English miles per hour.	Velocity in ft. in one second.	F in feet.	*f* in parts of the weight.
5	7·3	0·54	0·017
10	14·6	2·15	0·070
15	22·0	4·84	0·151
20	29·3	8·60	0·270
40	58·6	34·42	1·080
60	88·0	77·44	2·420
100	146·6	215·11	6·722

From an examination of the formulæ, it is evident that the centrifugal forces vary inversely as the radius of curvature, the velocity being the same: that is, as the radius of the curvature or bend in the road *increases*, the centrifugal force *decreases;* and, on the contrary, when the radius of the turn decreases, the centrifugal force increases. Therefore, as any other assumed radius is to 100 feet, that adopted in computing the foregoing table, so is the centrifugal force stated in the table to that for the radius required. Hence the effects of centrifugal force may, by this means, be estimated for any other curvature wanted. Thus, let the radius be 50 feet, one-half of 100, and F and *f* will be doubled, &c. From the principles of centrifugal forces, the centre of gravity is virtually thrown aside from R, *Fig.* 6, where it would be if the carriage were at rest, or moving forward in a straight line to R′; so that when the velocity is about ten English miles an hour, and the radius of curvature 100 feet, if the vertical line RE, passing through the centre of gravity R, were 32 feet in length, then RR′ would be by the table 2 feet nearly; that is, RR′ is $\frac{1}{16}$th of RE, or of the height of the centre of gravity above the road nearer the wheel EM, if the carriage turn rapidly at the rate of ten miles an hour, or $14\frac{1}{2}$ feet in a second of time round A as a centre, at the distance AE of 100 feet. It would be twice $\frac{1}{16}$th, or $\frac{1}{8}$th, if AE were 50 feet, which is not an uncommon case. In ordinary circumstances, the centre of gravity is less than 4 feet above the road, and therefore it might generally be about $\frac{1}{4}$th of 4 feet, or $\frac{1}{2}$ foot thrown aside from E to F, which would render the carriage, on such an inclined plane, just ready to overset. At twenty miles an hour, the centrifugal force, compared with gravity, is, from column 3d, 9 feet nearly, or $\frac{9}{32}$ of the height of the centre of gravity, or say, for the sake of simplicity, one-third of that height; so that, if the centre of gravity be 4 feet above the plane of the road, as formerly supposed, it would in effect be thrown aside by this means, nearly $\frac{1}{3}$ of 4, or $\frac{4}{3}$ foot, equal to $1\frac{1}{3}$ foot, or 1 foot 4 inches. Supposing the distance between the bottoms of the wheels to be 5 feet, then this effect of centrifugal force would be the same as if the carriage were moving on an inclined plane having a rise of 1 foot 4 inches in 5 feet, or at an angle of 15°. In like manner, the investigation might be carried to higher velocities; but enough, it appears, has been said to prove the danger of high velocities at rapid turns or curves in a road. On account of the good shape of the wheels, axle, and body of the carriage in *Fig.* 7, it is clear it would be just stable, since *rr′* would be less than RR′, on account of the centre of gravity being lower than that of *Fig.* 6, which is just ready to overset. Consequently *r′ e*, the vertical passing through the centre of gravity, would be just within the wheels, and the carriage would possess some degree of stability; while ϱ ε, (*Fig.* 8,) the vertical passing through its centre of gravity, just meets the

outer side of the wheel, though the centre of gravity ϱ itself, from the capacity of the carriage, derived from its peculiar shape, is the lowest of all the three forms, and therefore most favourable for stability. But the evil in this last case arises from the bad shape of the axle, which is considerably bent at the shoulder, and brings the bottoms of the wheels too close; therefore the centrifugal force throws the centre of gravity into the vertical line $\rho' n$ without the base, and overturns the carriage as easily as that shown by *Fig.* 6.

The proper size of the wheels is also a very important object in a well-constructed carriage. They ought not to be made too high, otherwise the horse draws disadvantageously, nor too low, since the friction would then be greater than necessary or expedient. Many vehicles are at the present time very improperly carried on remarkably small wheels, which causes great additional exhaustion to the horse, from the effects of friction, unless the roads be very smooth and well made. It is perhaps difficult to say what ought, in every case, to be the precise height of the wheels. It may generally be remarked, that they may vary between $3\frac{1}{2}$ and $5\frac{1}{2}$ feet in diameter, but cannot properly fall short of the one, nor exceed the other, without disadvantage. The fore-wheels in four-wheeled carriages are, in general, smaller than those behind, for the purpose of turning more easily, and giving a better position to the line of draught. otherwise they would be better if they were all of the same size. A great deal has been written on the relative qualities of wheels which have broad or narrow felloes; and opinions are generally given in favour of the former. The reasons assigned are, that the narrow wheels have a tendency to cut up and materially injure the roads; whereas, on the contrary, the broad wheels, acting like a roller, smooth down, consolidate, and harden them. This, as a general principle, is undoubtedly true; but the question still remains, What is the most advantageous breadth? It is not very easy to answer this question satisfactorily. By giving a considerable breadth to the wheels, they no doubt act as a roller, and are advantageous to the roads; but, at the same time, they become heavier by the additional wood and iron, supposing the hoops nearly of the same thickness, and they cannot well be reduced in thickness inversely as their breadth, otherwise they would be too thin to afford proper support to the felloes, and would require a frequent changing of the iron, which would be both troublesome and expensive. This would, in some degree, counterbalance the advantage to the roads, by the disadvantage of trouble, expense, and the additional load upon the cattle employed as a moving power. The difficulty appears, then, to be to combine the greatest advantage with the least disadvantage; and this will be accomplished by making them neither extravagantly broad nor too narrow, according to the size and nature of the cart or carriage, and the roads on which it will generally be employed. From $2\frac{1}{2}$ to 5 inches may be the limits within which they ought to be kept, except in extraordinary cases.

We now proceed to consider the agent generally employed in wheel-carriages as a moving power. A horse, when treading in a mill-path, at the rate of $2\frac{1}{2}$ miles an hour, will, on an average, raise about 150 lbs. by a cord hanging or passing over a pulley capable of easy motion, which is equivalent to 33,000 lbs. 1 foot high in a minute. This serves as a scale to measure the effective exertion of a horse, and is generally denominated a horse-power. Messrs. Boulton and Watt adopt a result somewhat less, or 32,000 lbs., in estimating the effect of their steam-engines, and Tredgold only 27,500. In different varieties of the horse, the power is doubtless different, and perhaps 30,000 lbs. may be a fair approximate value, in round numbers; and, when compared with the strength of a man, the effect of a horse will be, in ordinary circumstances, nearly equivalent to that of five or six men. A horse generally works with advantage about eight hours a-day only, while a man commonly can work, without injury, at least ten. The action of a horse is indeed greatly reduced by the length of time during which he works, though the rate of decrease is not perhaps well known. Writers on this subject have advanced different hypotheses, and given formulæ to ascertain the effects under various circumstances of load and velocity, and some of them are at least tolerably good, by affording approximations somewhat useful. Thus, according to Euler, if f be the force which an animal exerts, measured by the weight with which it is actually loaded, in the manner just mentioned, F the utmost effort which the animal can exert, or the resistance which, at a dead pull, it is just able to overcome, v the velocity with which the same animal is moving with a given load, V the velocity with which the power of drawing or carrying a load entirely ceases, then

$$f = \mathrm{F}\left(1 - \frac{v}{\mathrm{V}}\right)^2 \quad \text{.....(A)}$$

This formula, originally proposed by Euler, from theoretical considerations, has been shown by M. Schulze to be pretty near the truth, by direct experiments. The effect of animal strength, or quantity of work done in a given time, will be proportional to $f \times v$, or as the product of the force employed multiplied by the velocity of the animal's motion. It is also measured by E, the effect, which will be

$$\mathrm{E} = \mathrm{F}v\left(1 - \frac{v}{\mathrm{V}}\right)^2 \quad \text{.....(B)}$$

This, by the principles of the differential calculus, becomes a maximum when $v = \frac{\mathrm{V}}{3}$, and $f = \frac{4\mathrm{F}}{9}$; that is, the effect will be greatest when the animal moves with one-third of the speed with which, at its greatest velocity it is only able to move itself, without carrying any load, and at the same time is loaded with four-ninths of the load it is capable of moving. It also appears that the greatest effect produced will be represented by the product of the two last, or

$$f \times v = \frac{4}{27} \times \mathrm{F} \times \mathrm{V} \quad \text{.....(C)};$$

that is, multiply the greatest weight which a horse can move at a *dead pull*, by the greatest velocity with which he can travel without being able to move any weight, then $\frac{4}{27}$ths of this product will be the greatest effect; or the product of the weight which he ought to exert to move a load, and the velocity at which he ought to travel.

Desaguliers, one of the more early writers on this subject, states that a horse drawing a weight out of a deep well, by a rope passing over a pulley having little friction, will raise 200 lbs. for eight hours together, at the rate of $2\frac{1}{2}$ miles an hour. Supposing the horse in this case to work to the greatest advantage, which is known to be nearly true, there would be obtained for the horse the value of F in formula (A), equal to 450 lbs. $\mathrm{V} = 7\frac{1}{2}$ miles an hour, v the known velocity, being $2\frac{1}{2}$ miles an hour.

Hence $f = 450\left(\frac{7.5}{7.5 - 2.5}\right) = 8\,(7.5 - v)^2 = 200$ lb. (D)

This result seems to be rather too great, when compared with some late experiments. In the eighth volume, new series, of the London Philosophical Magazine, p. 22, Mr. B. Bevan, civil engineer, has given the results of eight series of experiments on the power of horses working in the plough, which, at a mean for 144 horses, gives 163 lbs. for the constant force of each horse exerted in drawing the plough. If the third experiment be rejected, as it is so much under all the others, the mean would be 168 lbs. for

each horse walking at the rate of $2\frac{1}{2}$ miles an hour, whence as before,

$$f = 378\left(\frac{7.5-v}{7.5}\right) = 6.72\,(7.5-v)^2 = 168 \text{ lb.}\ldots.(E)$$

When the work of a horse is estimated by the load which he draws in a cart or waggon, it generally bears some relation to that load, according to the good or bad construction of the cart, and the more or less easy motion of the wheels. Though accurate experiments on the friction of wheel carriages have never been made with due care on a sufficiently extensive scale, yet no great error can be committed in supposing the friction on the road with a carriage of the ordinary construction, on the usual roads, to be between $\frac{1}{8}$ and $\frac{1}{12}$ of the load. If, then, a horse draw a ton in a cart, which a strong horse will continue to do for several hours together, his action may be supposed the same as if he raised the twelfth part of a ton, or 186 lbs., perpendicularly against the force of gravity, as in the case formerly mentioned. To raise a weight of 186 lbs., at the rate of $2\frac{1}{2}$ miles an hour, may, from the consideration of the action of a horse in a cart, be taken as nearly the average work of a strong draught horse in good condition. This is somewhat less than the estimate of Desaguliers, and a little more than that of Mr. Bevan, and it would give—

$$f = 7{\cdot}44\,(7{\cdot}5-v)^2 = 186 \text{ lbs.}\ldots\ldots(F)$$

The mean of all these co-efficients, 8, 6·72, and 7·44, will be 7·17, or, for simplicity, about 7 in whole numbers nearly, which finally give—

$$f = 7\,(7{\cdot}5-v)^2 = 175 \text{ lbs.}\ldots\ldots\ldots(G);$$

where v is, as usual, one-third of the greatest velocity ($7\frac{1}{2}$), or $2\frac{1}{2}$ miles an hour for strong draught horses. Indeed $7\frac{1}{2}$ miles an hour will be nearly the greatest velocity of such horses as are generally used in waggons and heavy carts, though, for those breeds of horses which run in mail-coaches, it must be too small, since they generally go at the rate of 10 miles an hour for one stage of 10 or 12 miles twice a-day, when they receive a good rest between them. From this circumstance, it is evident that V, or the greatest velocity, must vary according to the quality of the horse, in relation to the manner in which the animal may be crossed with the finer breeds, while F must likewise change its value somewhat indirectly as V, as it is well known that slow heavy horses, at a moderate pace, can exert greater force, while light horses, at a considerable velocity, exert less. It is not too much to estimate V at 15 miles an hour for the latter kind of horses, and F at 180 lbs. or 200 lbs., about one-half the former, for strong draught horses, and consequently

$$f = 180\left(\frac{15-v}{15}\right)^2 = \tfrac{4}{5}\,(15-v)^2 = 80 \text{ lbs.}\ldots(H)$$

supposing v to be $\frac{1}{3}$ of V (15) or 5 miles. By this means, the relative effects at their maximum value will be easily found from formula (B) or

$$f \times v = 175 \times 2\tfrac{1}{2} = 437\tfrac{1}{2} \text{ for cart-horses.}$$
$$f \times v = 80 \times 5 = 400 \text{ for coach-horses.}$$

So that the greatest effects by these different kinds of horses, when the most favourable velocity is combined with the best weight, are very nearly equal; and the greater strength of the draught horse is, in a great degree, counterbalanced by the greater velocity of the coach-horse.

To point out clearly the relative effects produced by these two kinds of horses at different velocities, the following table is given. Part I. for cart-horses, and Part II. for coach-horses.

TABLE I.

I. Cart-Horses.			II. Coach-Horses.	
v	f Form. (H).	E or $f \times v$	f Form. (I).	E or $f \times v$
Miles.	Pounds.	Effect.	Pounds.	Effect.
0	394	0	180	0
1	296	296	157	157
2	212	424	135	270
$2\frac{1}{2}$	175	437	125	312
3	142	426	115	345
4	86	344	97	388
5	44	220	80	400
6	16	96	65	390
7	2	14	51	357
$7\frac{1}{2}$	0	0	44	337
8	...	...	39	312
9	...	...	29	261
10	...	...	20	200
11	...	...	13	143
12	...	...	7	84
13	...	...	3	39
14	...	...	1	14
15	...	...	0	0

In this table, the first column contains the velocity of the horse in miles an hour; the second contains the force which a cart-horse is capable of exerting, in pounds avoirdupois, at the different velocities marked in the first column; the third, the effect or product of the velocity multiplied by the force in pounds which the animal can exert at that velocity. The second part, for coach-horses, contains two columns corresponding to those in Part I. for cart-horses. By inspecting this table, it will be found, by columns first and second, that a cart-horse works most advantageously when moving at a rate of between two and three miles an hour, and exerting a force in pulling of between 150 lbs. and 200 lbs., since the numbers in the third column are then greatest, and they decrease at both a greater and smaller velocity, and consequently the labour becomes less effectual. Comparing column first with the two columns in part second, it appears that the most effective rate of a coach-horse is five or six miles an hour, when exerting a force of traction of between 60 lbs. and 100 lbs.; consequently, there is a loss of effect when coach-horses move either faster or slower than this rate. No doubt the mail-coaches move faster than this rate (almost double indeed), but then the horses can exert little force if they do not injure themselves, or, if they are compelled to exert considerable force, they are worn out in a few years if they run two stages exceeding eight or ten miles a-day.

In order to illustrate this subject more fully, it will be necessary to have recourse to investigation Let f be the force exerted by the muscles of the animal, which is continued for a day, b the weight of the animal itself, s the space described in a given time, and v the velocity; then, by the principles of dynamics, v will vary as $\sqrt{\frac{fs}{b}}$. (Hutton's Course of Mathematics, vol. ii. § 133.) Now, the space s will be inversely as the duration of a day's work, denoted by d, or s is as $\frac{1}{d}$, and, consequently, v is as $\sqrt{\frac{fs}{bd}}$. For a horse of average strength, $f = 250$ lbs. nearly, and b about 1000 lbs., or, in general, the force exerted by the muscles will be about one-fourth of the weight of the animal's body; and as f, s, and b are all constant, it follows that

$$v \text{ is as } \sqrt{\frac{1}{d}} \ldots\ldots\ldots(I);$$

or, in words, the velocity varies inversely as the square root of the length of the day estimated in hours of working. It has already been shown, that the maximum velocity of a strong cart-horse is about 7·5 miles an hour, and that of ordinary coach-horses about 15 miles an hour, and that they cannot keep up that speed without injury for more than one hour. On these principles, the following table shows the duration of labour, and greatest velocity of a horse of each kind, in miles per hour, which, by interpolation, may serve for any other velocity required.

TABLE II.

Duration of Labour,	H. 1	H. 2	H. 3	H. 4	H. 5	H. 6	H. 7	H. 8	H. 9	H. 10
Greatest velocity. Cart-Horse,	M. 7·5	M. 5·3	M. 4·3	M. 3·7	M. 3·4	M. 3·0	M. 2·8	M. 2·6	M. 2·5	M. 2·4
Greatest velocity. Coach-Horse,	M. 15·0	M. 10·6	M. 8·6	M. 7·5	M. 6·7	M. 6·1	M. 5·7	M. 5·2	M. 5·0	M. 4·8

This table will represent very nearly the rate of decrease of velocity by an increase of the duration of the time of labour on a level road. But if the road be inclined the velocity of ascent will be diminished in the ratio of the sine of the angle of elevation, or it will be increased in descent in the same ratio; that is, if the road rise or fall one foot in a hundred, the velocity will be diminished or increased by about one-hundredth of that stated in the table. The results in the table are those corresponding to a horse loaded very slightly, so as to continue to do so day after day without being injured, and must therefore be the utmost limits of velocity, though the work done must be little or nothing. It is also obvious, that if the load be so great that the horse can just move it, the work done in this case will also be nothing; but between these limits of velocity and power there must be a ratio at a certain point, which will produce the greatest quantity of useful effect, and must therefore be the most advantageous for the application of horse-power. To obtain this quantity, let V be the maximum velocity when unloaded, v the actual velocity, as in formula (B), or $E = F v \left(1 - \frac{v}{V}\right)$. Let $V - v = u$, then $F \frac{v}{V^2} (V - v)^2 = F \frac{v}{V^2} \times u^2 = F \frac{u^2}{V^2} (V - u)$. Omitting the constant quantities, and making $u^2 (V - u)$ a maximum, by putting its fluxion equal to nothing, that is, $2 V u\,du - 3^2 u\,du = o$. Whence $u = \frac{2}{3} V$, and therefore $v = V - u = V - \frac{2}{3} V$, or

$$v = \frac{1}{3} V \quad . \quad . \quad . \quad . \quad (L).$$

Hence the velocity required to produce the maximum effect is one-third of the greatest velocity at which the animal is capable of moving. This gives about two and a-half miles an hour for cart-horses, and five miles an hour for coach-horses, when working eight or nine hours a-day. The time thus obtained seems to answer very well for draught-horses, but it is too long for mail-horses, where less effect but greater speed is required. It is easy to regulate this by the table. Thus, if a set of coach-horses have to run two stages of an hour each, or two hours on the whole in a day, then under 2 h., and opposite coach-horses, will be found 10·6 m., or about ten and a-half miles, the rate at which they may run without much injury, when slightly loaded, during one day of twenty-four hours, when well fed, and receive a good rest between the times of their running their prescribed stage. Since, by formula (A) $f = F \left(\frac{V - v}{V}\right)^2 = F \frac{v^2}{V^2}$, and $u = \frac{2}{3} V$, we have

$$f = F \frac{\frac{4}{9} V^2}{V^2} = \frac{4}{9} F \quad . \quad . \quad . \quad . \quad (l),$$

as already remarked, or the power at the maximum is four-ninths of the force exerted by the muscles at their greatest capability. This conclusion ought therefore to be attended to, when the greatest quantity of work is required from strong sound horses.

It will now be useful to show the addition of expense for a variation of velocity from the maximum of useful effect. Since the expense must be inversely as the effect produced, if the maximum, Table I., be taken for unity, then will be obtained

TABLE III.

Velocity.	Proportional Expense.	
Miles per hour.	Cart-Horses.	Coach-Horses.
0	Infinite.	Infinite.
1	1·48	2·55
2	1·03	1·48
2½	1·00	1·28
3	1·03	1·16
4	1·27	1·03
5	1·99	1·00
6	4·55	1·03
7	31·21	1·12
7½	Infinite.	1·19
8	...	1·28
9	...	1·53
10	...	2·00
11	...	2·80
12	...	4·76
13	...	10·26
14	...	25·57
15	...	Infinite.

From this table it will appear that, if a cart-horse walk at the rate of two and a-half miles an hour, the expense will be the least; but if slower or faster than this, the expense will be increased. Thus, at 5 miles an hour the expense will be doubled for a heavy cart-horse, while it will be the least for lighter coach-horses. The latter would be doubled at ten miles an hour, the usual rate of mail-coaches, consequently our mails are accelerated at great expense.

By comparing the three tables just given, a fair estimate of useful effect may be obtained, involving the velocity, duration of labour per day, and relative expense; and the proper value of each may be so chosen as to suit the object most particularly in view. Thus, a draught horse moving on a railway will produce the greatest effect at least expense, when moving at the rate of 2½ miles an hour, exerting a force of traction of nearly 175 lbs. (Table I.), and will work eight or nine hours a day (Table II.), on an expense denoted by 1 (Table III.), or the least possible expense. If the velocity be increased to 4 miles an hour, the animal will be able to exert a force of 86 lbs. only, work about three and a-half hours, at an expense of 1·27, or an increase of 27 per cent. In like manner, similar consequences may be drawn for other velocities and for other kinds of horses. Thus a coach-horse running at the rate of 10 miles an hour, can exert safely a force of traction of about 20 lbs. (Table I.), can work two hours a-

day only (Table II.), and that at an expense denoted by 2 (Table III.), that is, this velocity is obtained at an expense of cent. per cent., and so on of others. It is not affirmed that the conclusions derived in this manner are strictly accurate in every case that may occur, but that they are approximations, which will be found useful in making estimates of animal performance, not far from the truth.

WHEEL-DRAG. See Drag.

WHEEL-PLOUGH. See Plough.

WHEEZER. See Broken Wind.

WHEY. The liquid of milk which remains after the abstraction of the curd for sweet-milk cheese, or after the separation in any other way of the main portion of the milk's caseous and butyraceous principles. It is properly identical with the serum of the milk, but it also comprises small and variable unseparated portions of the caseum and the butyrine; and it varies widely in constitution according to the different species of the milk, or according to the different conditions of the same species, and according also to the manner in which the main bulk of the caseum and the butyrine are separated. Its chief constituent as to bulk is water; and its other proper constituents are lactic acid, sugar of milk, and several salts. See the articles Milk and Lactic Acid. The sugar of milk gives it its sweetish taste, and may readily be separated from it by evaporation, and is manufactured on a large scale in Switzerland, and applied to pharmaceutical purposes, and in particular is the vehicle of all the granulated medicines of the homœopathists. It has not a strong saccharine taste; but it yields by distillation every product obtainable by that process from vegetable sugar; and if it be dissolved in water, clarified with the white of egg, and evaporated in the usual manner, it will form delicate white crystals. The odour of its empyreuma resembles that of benzoic acid. The mucic acid found in all gums occurs in sugar of milk, and formerly took from it the name of saccholactic acid. This acid, when pure, is obtained in the form of a white powder; it decomposes the chlorides of barium and calcium, combining with the bases after they have absorbed oxygen; and it forms two sets of salts with soda and potash, and nearly insoluble salts with the metallic oxides.

Whey is used in the families of many farmers as a beverage; it is also used, on many farmeries in Scotland, for making a very palatable and wholesome variety of oatmeal porridge; and it is commonly given as both food and drink to cows, horses, and hogs. The whey obtained from the milk of three or at most four cows will, with a very small supply of other food, raise a young pig, from April till December, to a weight of from 12 to 25 stones; and, if the creature belong to any ordinarily good breed, will render its pork of very fine quality. In some slovenly dairies, whose business is currently managed in an ignorant or unskilful manner, butter is extracted from whey. If the curd is set and the whey taken off at the proper temperature, the butter that can be extracted from the whey will not indemnify the labour in collecting it. But if the milk is too hot when it is coagulated, or the curd too roughly handled, such a portion of the butyraceous matter will go off with the whey as it may be proper to collect. This is bad economy in itself, and also does great injustice to the cheese, for whatever butter is found in the whey is robbed from the cheese.

WHIMBREL,—scientifically *Numenius Phæopus*. A British bird of the longirostrous family of Grallæ. It is a congener of the curlew, and very closely resembles that bird in at once plumage, haunts, and habits; but is considerably smaller, and very much less abundant. It is called in some districts the half-curlew and the jack-curlew. It is occasionally seen in many parts of our shores in winter; but is most plentiful in May and in autumn. The male measures 16 inches in length,—the beak 3 inches; and the female measures about 18 inches in length,—the beak 3½ inches. The flesh is of similar excellence to that of the curlew. Whimbrels feed on worms and insects; and utter a cry or note which resembles a quick repetition of the articulations "tetty, tetty, tetty, tet." The eggs are pear-shaped, 2 inches 5 lines long, 1 inch 8 lines broad, of a dark olive brown colour blotched with darker brown, and four in number.

WHIN. See Furze.

WHINCHAT,—scientifically *Rubicola rubetra*. A British bird of the warbler group of Passerinæ. It is a congener of the stonechat, and very much resembles that bird in at once appearance, haunts, and habits; and it takes its popular name of whinchat from its partiality for the furze. It darts with undulating flight from bush to bush of furze in a thicket or on a moorland pasture, and always perches on the uppermost twigs of a bush; and pours out its song either from that position, or while hovering in the air over it. It appears about the middle or end of April; and it becomes fat, and a desirable object for the gourmand, in August. It feeds on worms, insects, molluscs, and berries. Its total length is rather less than 5 inches; its neck, back, smaller wing-coverts, and the top of its head are a mixture of pale brown and very dark brown; over its eye and ear-coverts is an elongated streak of white; its throat and breast are delicate fawn colour; and its belly is pale buff. The nest is generally built on the ground; and is formed of mosses and bents, and lined with fine bents and other grasses. The eggs amount to five or six, and have an uniform bluish green colour, with some minute specks of dull reddish brown, and measure 9 lines in length and about 6½ in breadth.

WHINSTONE. Any crystalline or unstratified rock except the quartzose and the granitic. The name is a popular one, and very loosely used, and has different latitudes of meaning among different persons and in different districts. It

most commonly designates the harder kinds of traps, — particularly basalts, greenstones, and compact porphyries; but it is sometimes made to include all greyish or bluish stratified rocks,— particularly the harder sorts of greywacke.

WHIRL-BONE. The joint, in the horse, between the thigh-bone and the pelvis. It is very strong, and very little liable to dislocation; yet it sometimes suffers extension of its ligaments,— and then the horse is said to be lame in the whirl-bone.

WHISKEY. See Alcohol.

WHISTLER. See Broken Wind.

WHITE BEAM TREE. See Aria.

WHITE BIRCH. See Birch.

WHITE BLIGHT. See Aphis.

WHITE CEDAR. See Cypress.

WHITE CLOVER. See Clover.

WHITE COPPER. An alloy consisting of 40·4 per cent. of copper, 25·4 of zinc, 31·6 of nickel, and 2·6 of iron.

WHITE FIORIN. The white bent grass,— *Agrostis alba*. See the articles Agrostis and Fiorin.

WHITE LAND. Land with a chalky soil.

WHITE LEAD. See Lead.

WHITE POPLAR. See Poplar and Abele.

WHITE-ROT. See Pennywort.

WHITE SPRUCE. See Fir.

WHITE-THORN. See Hawthorn.

WHITETHROAT,—scientifically *Curruca*. A genus of British birds of the warbler family of Passerinæ.

The common whitethroat, *Curruca cinerea*, bears many provincial names, having reference to its note or appearance or habits,—such as whurr, wheetie-why, muff, maggy cut-throat, and Peggy nettle-creeper. Its total length is 5½ inches; its general plumage displays various shades of brown colour; its chin and its throat are white; and the lower part of its neck, its breast, its belly, and its flanks are pale brownish white tinged with rose colour. It is readily distinguished from the babillard by its general brown plumage and by its yellow legs, and from other small birds by the feathers being very full and bulging out around the throat. It makes its appearance about the third week of April; and is more generally diffused than any other of our immigrant summer warblers. It has a merry song, and often pours it out while mounting in the air like the titlark, or while flitting from hedge to hedge. It frequents thickets, the sides of woods, hedgerows with broad banks, and lanes abounding with low bushes, brambles, nettles, and rank herbage. It feeds on white caterpillars, on other larvæ, on some perfect insects, and on most of the small garden fruits and berries; and it ranks as only a partially destructive hedge-bird, and has generally been accused of doing much more mischief than it really perpetrates. Its nest is built in a low bush or in a tangled mass of rank vegetation; and is a neatly woven structure of grass and straws and hair. The eggs amount to four or five, and have a greenish white colour spotted and sprinkled with ash-brown and with two shades of ash-green, and measure 9 lines in length and 6½ in breadth.

The lesser whitethroat, *Curruca garrula*, is rather shorter and more slender than the common species. Its total length is 5¼ inches; its head, neck, and back have a smoke-grey colour; its chin, throat, and breast are almost pure white; and its belly also is white, but tinged with red as far as the vent. Its habits and food are very similar to those of the common whitethroat. Its eggs measure each 8 lines in length and 6 in breadth.

WHITE-TREE. See Cajeput.

WHITE VINE. See Clematis.

WHITE VITRIOL. The sulphate of zinc. It is commonly prepared in England by direct combination of zinc and sulphuric acid, but in Germany by a process commencing in the exposure of roasted blende to the air and humidity. It crystallizes in transparent, colourless, right rhombic prisms, terminated by quadrangular summits; it slightly effloresces in the air, and is soluble in 2½ times its own weight of water at 60° Fahrenheit; and it is inodorous, and has a slightly acidulous, styptic, metallic taste. It is used in both human and veterinary medicine; but in large doses is a poison. It serves as a human tonic in dyspepsy, fluor albus, and some convulsive affections; as a human emetic in cases which require almost instantaneous emetic action; and as a lotion in some kinds of superficial inflammations. It serves in farriery as a good general caustic, as a lotion in the after-stages of inflammation of the eye, as a good application to indolent ulcers and in the latter stages of grease, and, under discriminating conditions, as a tonic for the horse but not for the cow. "It has been recommended as a tonic remedy for the horse," says White, "in doses of from half an ounce to six drachms; but I have seen it given to the extent of eight ounces at one dose to a glandered horse by way of experiment, without producing much inconvenience. The only effect produced, was upon the urinary organs, occasioning a frequency and a little difficulty in staling."

WHITE WATER. Tepid water containing bran or oatmeal, and given as a drink to a horse. Many horses who are bad feeders, and who become incapable of eating after very fatiguing labour or exercise, are refreshed and sustained by a drink of this kind, containing from a pint to a quart of oatmeal.

WHITFIELDIA. A recently discovered genus of ornamental exotic plants, of the acanthus family. The brick-coloured species, *W. lateritia* was introduced to Britain from the interior of Sierra Leone, a few years ago, by the gentleman in honour of whom the genus is named. It is a small, bushy, evergreen, stove shrub; and thrives best in a light open loamy compost. Its branches

are spreading and rather tortuous; its leaves are petiolate, opposite, oblong-ovate, entire, and somewhat leathery; and its flowers come out in racemes at the terminations of the branches. The racemes are disposed opposite to each other, like the leaves, and are drooping, and furnished with coloured bracteas; the calyx or outer covering proceeds from between the bracteas, and is composed of four segments, funnel-shaped, and of a brick-red colour; and within this is situated the corolla, projecting about half of its length beyond the calyx, a figure between bell-shaped and funnel-shaped, and divided into two portions, called the upper and the lower lips; and the former of these is again separated into two segments, and the latter into three.

WHITLOW-GRASS. Plants of the draba genus, and also the pepperwort draba. See the article DRABA.

WHOLE SCHŒNUS. See ISOLEPIS.

WHORL GRASS. See CATABROSA.

WHORTLEBERRY. Fruiting and ornamental plants of the vaccinium genus and heath family. The name is sometimes given loosely to all the vacciniums; but it more properly belongs only to the indigenous fruiting species,—the chief two of which are noticed in the articles COWBERRY and MYRTLE BILBERRY. See also the article VACCINIUM.

The bog whortleberry, bog bleaberry, or great bilberry, *Vaccinium uliginosum*, grows on boggy mountains in many parts of Britain, and is particularly abundant in the Scottish Highlands. It is a deciduous shrub; and has commonly a height of about two feet. Its branches are cylindrical; its leaves are obovate, entire, and smooth; its flowers grow several together, and have a flesh or pink colour, and bloom in April and May; and its berries are comparatively large and of a bluish black colour, and are less acidulous and less wholesome than those of the myrtle bilberry.

WIDOW-WAIL. See CNEORUM.

WIGANDIA. A recently discovered genus of ornamental exotic plants, of the hydrolea family. The Caraccas species, *W. caracasana*, was introduced to Britain from Caraccas in 1836; and is a small evergreen shrub, carrying lilac-coloured flowers, and delighting in a soil of loamy peat.

WILD BASIL. See BASIL (WILD).

WILD BEET. See STATICE and BEET.

WILD BLITE. See BLITE.

WILD BUGLOSS. See BUGLOSS (WILD).

WILD CHAMOMILE. See MATRICARIA and CHAMOMILE.

WILD CUMIN. See CUMIN (BASTARD).

WILDFIRE. See ERYSIPELAS.

WILD LIQUORICE,—botanically *Abrus*. An ornamental, tropical, climbing plant, of the kidney-bean division of the leguminous order. It is a native of the West Indies; and was introduced to Britain in the latter part of the 17th century. It constitutes a genus of itself, and bears the specific name of *precatorius*. It commonly attains a height of about 12 feet, and carries pale purple flowers from March till May; and it loves a soil of sandy peat, and is propagated from seeds.

WILD OAT. See OAT.

WILD OLIVE. See OLIVE (WILD) and SUMACH.

WILD PURSLANE. See SPURGE.

WILD RADISH. See RADISH and WEED.

WILD SERVICE. See SERVICE.

WILD TAMARIND,—botanically *Codarium*. A small genus of ornamental, tropical, evergreen ligneous plants, of the leguminous order. Two species, the acute-leaved and the obtuse-leaved, the former about 20 feet high, the latter about 12 feet high, and both carrying pale red flowers in February, have been introduced to British gardens from Sierra Leone; and they love a soil of loamy peat, and are propagated from cuttings.

WILD TANSY or GOOSE TANSY. See POTENTILLA.

WILD THYME. See THYME.

WILD VINE. See VINE.

WILDERNESS. A grove traversed by meandering or labyrinthine walks. It has long been a favourite feature of many a pleasure-ground and landscape garden. "Wildernesses," says Millar, "should always be proportioned to the extent of the gardens in which they are made; for it is very ridiculous to see a large wilderness planted with tall trees in a small spot of ground; and, on the other hand, nothing can be more absurd, than to see little paltry squares, or quarters of wilderness work, in a magnificent large garden. As to the situation of wildernesses, they should never be placed too near the habitation, nor so as to obstruct any distant prospect of the country,—there being nothing so agreeable as an unconfined prospect; but where from the situation of the place, the sight is confined within the limits of the garden, nothing can so agreeably terminate the prospect as a beautiful scene of the various kinds of trees judiciously planted; and if it is so contrived, that the termination is planted circularly, with the concave towards the sight, it will have a much better effect, than if it end in straight lines or angles. The plants should always be adapted to the size of the plantation; for it is very absurd for tall trees to be planted in the small squares of a little garden, and in large designs small shrubs will have a mean appearance. It should also be observed, never to plant evergreens amongst deciduous trees; but always to place the evergreens in a wilderness in a separate part by themselves, and that chiefly in sight." See the article LANDSCAPE GARDENING.

WILLOW,—botanically *Salix*. A large genus of ligneous plants, of the amentaceous order. They belong to the *Diœcia Diandria* of the Linnæan arrangement; and they group among the Amentaceæ with the poplars, and have all more

or less of an aquatic or sub-aquatic habit; but they comprise a wondrous diversity of size and form and character, and present to the botanist great difficulties and complexities of classification. About 75 species, besides a number of very distinct varieties, are natives of Britain; and about 160 have been introduced from other countries,—a very large proportion of them from Continental Europe, and particularly from Switzerland. A few are undershrubs, varying in height from a span or 6 inches to 2 feet; a considerable number are trees, varying in height from 25 to 70 feet; and the rest are shrubs, varying in height and character, at all stages, from undershrubs to trees. Three are tender evergreen tall shrubs and small trees; one is a hardy evergreen undershrub; a few are small, low, hardy, deciduous trailers or procumbents; a few are hardy deciduous undershrubs; and all the rest are hardy deciduous shrubs and trees. Many have villous leaves; many have smooth serrated leaves; and a few have smooth entire leaves. All may be propagated from cuttings; and most require a swampy situation; but a few thrive well on any common soil.

Many or most are ornamental; several are eminently medicinal; a few possess considerable value as timber-trees; and almost all are, in some way or other, useful. "The importance of the willow to man," says Loudon in his Arboretum Britannicum, "has been recognised from the earliest ages; and ropes and baskets made from willow twigs were probably among the very first of human manufactures in countries where these trees abound. The Romans used these twigs for binding their vines and tying their reeds in bundles, and making all sorts of baskets with them. A crop of willows was considered so valuable in the time of Cato, that he ranks the salictum, or willow field, next in value to the vineyard and the garden. In France, the leaves, whether in a green or dried state, are considered the very best food for cows and goats; and horses, in some places, are fed entirely on them, from the end of August till November. Horses, so fed, it is stated, will travel twenty leagues a-day without being fatigued. In the north of Sweden and Norway, and in Lapland, the inner bark is kiln-dried, and ground for the purpose of mixing with oatmeal in years of scarcity. The bark of the willow and also the leaves are astringent; and the bark of most sorts may be employed in tanning." "There is not a twig of the meanest willow," says Dr. Walker in his work on the Hebrides, "but what is turned to some useful purpose. The native willows supply the Hebrideans the use of ropes. A traveller there has rode during the day with a bridle made of them, and been at anchor in a vessel at night, where tackle and cable were made of twisted willows. In the islands of Colonsay, Coll, and Tiree, the people tan the hides of their black cattle with the bark of the grey willow. In Dumfries-shire, the bark of the apple-leaved willow is sold to the tanners, along with the oak bark, though at an inferior price. The barks of all the willows are of a very styptic nature; they are all capable of dyeing black, and therefore capable of being a tan." The foliage of the British willows, like that of the Continental ones, is greedily eaten by cattle; but, in consequence of its very astringent quality, it may be useful mainly in averting febrile attacks throughout morassy districts, or in situations much exposed to marshy vapours and miasmata, and may not be at all suitable or healthy to flocks who generally feed on dry pastures and breathe a pure dry air. The flowers of both male and female willows afford early and abundant food to bees. Most species of willows furnish an eminently effective fence against the encroachments of streams; for when planted on the banks, they spread their roots in all directions, and take deep and stubborn anchorage, and mat and consolidate the soil. The principal species expressly cultivated for the use of basket-makers are noticed in the article Osier; and the most abundant indigenous species of a rigid habit, forming rough bushes or large trees, and used in other departments of economy than basket-making, are, in many districts, popularly called sallows.

The common white willow, *Salix alba*, is a deciduous tree, and naturally abounds in moist situations, in woods and in the neighbourhood of towns and villages, in most parts of Britain and of Continental Europe. It usually attains a height of about 40 or 50 feet; and it grows quickly, and is an useful timber-tree when lightness of wood and cleanness of grain are required. Its bark is thick, full of cracks, and suitable for tanning, and is called by some writers *Cortex salignum* and *Cortex anglicanum;* its branches are numerous, and have a silky surface when young, and spread widely as they advance in age; its leaves are alternate, elliptico-lanceolate, pointed, silky on both surfaces, and glandular in the lowest serratures; and its flowers appear in April and May. This tree grows best in a deep rich soil by the side of water, and there attains a large size, and, if advantageously situated, has a very ornamental appearance, making a fine contrast in its slender silvery leaves to the dark foliage and dense masses of oaks and beeches on slopes and heights in its vicinity; but it rarely gets fair play or tolerable scope for developing itself as an ornamental plant, and is generally and most unworthily degraded to the condition of a pollard. A pretty well known variety of it, however, greatly excels the normal kind in at once handsomeness of appearance, rapidity of growth, and economical value of both bark and timber; and two other varieties, which might almost rank as distinct species, are the blue, *S. a. cærulea*, an indigen of moist meadows in some parts of England, —and the curled-leaved, *S. a. crispa*, found only on cultivated grounds, principally within parks and gardens. The bark of the white willow

abounds in salicin, and may be used as a substitute for Peruvian bark.

The golden willow, or yellow-branched willow, *Salix vitellina*, grows wild in the marshes of some parts of England, and of many parts of Continental Europe. It is a low deciduous tree, seldom attaining a height of more than from 15 to 20 feet; and it claims a place in ornamental plantations—not indeed for sake of any fine figure which it makes in summer—but on account of its smooth clear-yellow bark, which gives it a singular and striking effect among other trees in winter. Its leaves are smooth and serrated; and its flowers appear from March till May.

The sweet or sweet-scented or pentandrous willow, *Salix pentandra*, is a native of river banks in marshy and mountainous situations in many parts of Britain and of Continental Europe. It is a small deciduous tree; and commonly attains a similar height to the golden willow; but is capable of becoming a large timber-tree. It delights in a very wet situation; and commonly blooms from March till June; but has been observed throwing off its seeds and covered all over the top with its white seminal down in the beginning of December. Its bark is brown and smooth. Its leaves are far broader than those of any other willow, and have a general resemblance to those of the bay tree; they are smooth and of a shining green colour above, of a paler green below, and serrated on the edges; and they suffuse a delightful aromatic fragrance to a considerable distance after a shower, and plentifully emit it when bruised,—and for sake of this fragrance, the sweet willow deserves a place among ornamental plantations.

The triandrous willow, *Salix triandra*, inhabits river banks, wet woods, and similar situations in many parts of Britain, Switzerland, and Siberia. Its stem is erect, and, when not repressed or damaged, soars readily up to a height of 30 feet; its old bark peels off and falls toward autumn; its large branches are broad and solid, and crack angularly asunder like those of the plane tree; its young branches are erect, long, smooth, brownish, leafy, tough, and pliant, but are somewhat brittle at the insertion; its leaves are linear-oblong, serrated, smooth, and somewhat unequally sloping at the base; and its flowers bloom from May till August. This species is cultivated in England for white basket-work; and produces annual crops of tough, pliant, durable rods of 8 or 9 feet in length; but it comprises several varieties,—one of which, called the French willow, is cultivated in the eastern and south-eastern counties, and is more slender than the normal plant, and not near so tall.

The phylica-leaved willow, *Salix phylicifolia*, grows wild in a dwarfish state in the Scottish Highlands, and was long ago introduced to British collections with the habit of a small tree or tall shrub from the north of Sweden. It never at best attains so great a size as the triandrous willow. Its branches are numerous, flexible, tough, and serviceable for various purposes of the basket-makers; its leaves are lanceolate, smooth, serrated, and undulated; and its flowers grow in long catkins, and come out early in the spring from the sides of the branches, and soon afford a large quantity of down, which is wafted by the winds to a considerable distance. A variety of it occurs with broad leaves.

The almond-leaved willow, *Salix amygdalina*, is a native of the marshy grounds of Britain and of most parts of Continental Europe. It is a deciduous shrub, of commonly about 6 or 7 feet in height. Its branches are numerous, flexible, and tough, and are clothed with a light green bark; its leaves are lanceolate, pointed, serrated, smooth, eared at the base, and of a light green colour on both surfaces; and its flowers grow in oblong catkins, and appear in April and May, and turn to a light down in the summer. The branches or shoots of one year's growth are highly serviceable for basket-making; yet only those of what is called the old almond-leaved willow are well deserving of cultivation; for several varieties occur,—all of inferior value to the normal plant.

The crack willow, *Salix fragilis*, inhabits the banks of rivers in many parts of Britain and of the northern countries of Continental Europe. It is a small deciduous tree, and readily attains a height of 15 or 18 feet. Its branches are upright, and covered with a smooth brownish bark, but are very brittle and quite unfit for the uses of the basket-maker, and gave rise to both the popular and the botanic names of the species; its leaves stand on glandular footstalks, and are ovate-lanceolate, pointed, serrated, smooth, green on both surfaces, and from 3 to 5 inches long; and its flowers grow in long, slender catkins, with loosely disposed scales, and appear in April and May. The bark ranks with that of the common white willow as a good medicinal substitute for Peruvian bark. A variety called the almond-leaved crack willow has yellow-coloured bark, and casts it every year.

The goat willow, or great round-leaved willow, or common sallow, *Salix capria*, is a very abundant native of the woods of Britain and of most other parts of Europe. It delights in a dry rather than a moist soil. It is a deciduous tree of medium size, and readily or usually attains a height of about 30 or 35 feet. Its branches are cylindrical, smooth, shining, and of a dark green and brownish colour; its shoots are pubescent; its leaves are alternate, petiolate, oval, waved, rough, indented at the top, smooth and dark green above, and veined and densely woolly below; and its flowers grow in very large catkins, and have a yellow colour, and appear in April and May, and are much frequented by bees on their first coming out of their hives. The bark serves, like that of the white and the crack willows, as a good medicinal substitute for Peruvian bark; the

timber of old stems is admirably suited to many kinds of turnery; and the wood of the branches and of young stems is employed principally for hurdles and fuel. One variety of this species has long leaves ending in acute points; and another, called the striped sallow, has smooth leaves beautifully striped with white.

The Bedford, Dishley, Huntingdon, or Russel willow, *Salix Russelliana*, grows wild in the swampy grounds of some parts of England; and was first introduced to notice as a tree deserving of cultivation by the late Duke of Bedford; and has been found, on fair and ample trial, to be more profitable for at once its timber, its bark, and its rapid or economical habits of growth than any other tree-willow hitherto cultivated. It also possesses considerable claim to rank as an ornamental tree; and it has eminent adaptations for protecting the sides of streams, and defending their banks from encroachment. It has often been most injuriously confounded with the crack willow; though it exhibits almost a perfect contrast to that species in the aggregate of economical value, and can readily be distinguished from it by some of its most obvious characters. It is far handsomer, and has a lighter or brighter hue, and attains a far greater height and a far larger bulk; for it easily and commonly rises to the altitude of 40 feet, and is capable of acquiring the greatest girth. Its branches are long, straight, slender, cylindrical, flexible, very tough, smooth, and polished, and have none of the angularity in their insertion which those of the crack willow have, and may always be readily recognised from these when stripped of their foliage; its leaves are lanceolate, tapering at both ends, serrated all round, and very smooth,—and they have a much longer footstalk than those of the crack willow, as well as a different shape; and its flowers appear in April and May. The bark is very rich in both tannin and salicin; and therefore is eminently suitable for both the tanner and the physician. The timber possesses a high degree of at once lightness, toughness, and durability; and when newly cut is easily made to bend to any curvature; and when very old, in such situations as the cuppling of tolerably well constructed houses, is almost as hard as bone, very light, and still quite fresh; and it is well suited for boat-building and for many other uses. This valuable tree thrives best over a moist subsoil or near water.

The shining or hermaphrodite willow, *Salix hermaphroditica*, inhabits the banks of rivers in some parts of Britain, and in some parts of northern Europe. But it is a comparatively rare species; and is regarded by some botanists as merely a variety of the pentandrous willow. It commonly attains a height of 15 or 20 feet, and has a tree-like habit and an ornamental appearance. Its branches are numerous, erect, and flexible, and are clothed with a greyish bark; its leaves are ovate-lanceolate, acute, serrated, eared at the base, and green on both surfaces; and its flowers grow in long, narrow, loose catkins, and appear from March till June. This species is planted by the basket-makers to mix with other kinds for their different sorts of work.

The herbaceous willow, *Salix herbacea*, inhabits the mountains of various parts of Britain. It is a curious and striking contrast to the tree willows; for it is so small that six plants of it, roots, stem, leaves, and flower, may be placed between two leaves of a duodecimo volume. It commonly attains a height of about 5 or 6 inches, and blooms in June. But a variety of it found in Sunderland, or at least a plant possessing all its characters except size, commonly attains a height of about two feet. The species, however, both in its normal form and in this variety, is herbaceous principally in mere name and appearance, and has sufficient ligneousness to claim rank among undershrubs.

The brown willow, *Salix fusca*, inhabits moist heaths in various parts of Britain. It is a small, deciduous, ornamental shrub, commonly about 2 feet in height, having villous leaves, and blooming in May. Five varieties of it, all very distinct in character from the normal plant and from one another, and some of them remarkable for peculiarity of habitat, also grow wild in Britain. The prostrate, *S. f. prostrata*, is a creeper or procumbent of about a foot in height, inhabiting moist mountainous pastures; the stinking, *S. f. fœtida*, is a small-leaved creeper or procumbent of about 18 inches in height, inhabiting moist heaths; the creeping, *S. f. repens*, is a creeper of about 2 feet in height, inhabiting sandy heaths; the silvery, *S. f. argentea*, is a creeper or procumbent of about 4 feet in height, inhabiting sandy shores; and the trailing, *S. f. incubacea*, is a somewhat erect plant of about 4 feet in height, inhabiting sandy shores.

Hoffmann's willow, *S. Hoffmanniana*, is a timber tree of commonly about 30 feet in height, nearly allied to the triandrous willow, blooming in May, and inhabiting the river banks of Britain.—The lance-leaved willow, *S. lanceolata*, is a timber tree of about the same height as the preceding, blooming in April and May, and inhabiting the meadowy grounds of some parts of England.—The blackish broad-leaved willow, *S. nigricans*, is a large bushy plant, of commonly about 10 feet in height, blooming in April, and inhabiting the osier holts of England.—The shining willow, *S. nitens*, is a large shrub, commonly about 10 feet high, blooming in April, and inhabiting some of the mountains of Scotland.—The deceptive willow, *S. decipiens*, is a shrub of commonly about 8 feet high, blooming in May, and inhabiting the woods of some parts of England. —Bover's willow, *S. Boveriana*, is a bush of commonly about 8 feet in height, blooming in May, and inhabiting some of the mountains of Scotland.—Davall's willow, *S. Davalliana*, is a shrub of commonly about 6 feet in height, bloom-

ing in May, and inhabiting some of the mountains of Scotland.—The laurel-like willow, *S. laurina*, is a shrub of commonly about 8 feet in height, blooming in April and May, and inhabiting moist grounds in some parts of England.—The two-coloured willow, *S. bicolor*, is an undershrub, commonly about 2 feet high, blooming in May and June, and inhabiting stony hills in various parts of Britain.—The dark or petiolated willow, *S. petiolaris*, is a tall bushy plant, commonly about 10 feet high, blooming in April, and inhabiting some of the marshes of England.—Lambert's willow, *S. Lambertiana*, is a tall bushy plant, commonly about 10 feet high, blooming in March and April, cultivated for the use of basket-makers, and naturally inhabiting the banks of streams in some parts of England.—The apple-leaved willow, *S. malifolia*, is a small ornamental shrub, commonly about 3 feet high, blooming in April, and inhabiting some of the uplands of England.—The plum-leaved willow, *S. prunifolia*, is a small ornamental shrub, commonly about 3 feet high, blooming in April and May, and inhabiting some of the lofty mountains of Scotland.—The myrsine-like willow, *S. myrsinites*, is a small deciduous shrub, commonly about 3 feet high, blooming from April till June, and inhabiting some parts of the Scottish Highlands.—The veiny-leaved willow, *S. venulosa*, is an evergreen undershrub, commonly about 2 feet high, blooming in April and May, and inhabiting some parts of the Scottish Highlands.—The bilberry-leaved willow, *S. vacciniifolia*, is an ornamental undershrub, commonly about 2 feet high, blooming in April and May, and inhabiting some parts of the South of Scotland.—The keel-leaved willow, *S. carinata*, is a shrub of commonly about 3 feet in height, blooming in April and May, and inhabiting some of the lofty mountains of Scotland.—The little tree willow, *S. arbuscula*, is an ornamental undershrub, commonly about 2 feet high, blooming in April, and inhabiting some of the lofty mountains of Scotland.—The livid willow, *S. livida*, is an ornamental undershrub, commonly about 1 foot high, blooming in May, and inhabiting some of the heaths of England. All the species enumerated in this paragraph have smooth and serrated leaves.

The glaucous willow, *S. glauca*, is an ornamental undershrub, commonly about 2 feet high, blooming in May, and inhabiting some of the lofty mountains of Scotland.—The grey willow, *S. cinerea*, is a small tree, commonly about 15 or 18 feet high, blooming in May, and inhabiting the woods of Britain.—The hairy-branched willow, *S. hirta*, is a small tree, similar in height to the preceding, blooming in April and May, and inhabiting the woods of England.—The water willow, *S. aquatica*, is a tall shrub, commonly about 10 feet high, blooming in April, and inhabiting the wet thickets of Britain.—The acuminate willow, *S. acuminata*, is a small tree, commonly about 15 or 18 feet high, blooming in April, and inhabiting the moist woods of Britain.—Forster's willow, *S. Forsteriana*, is a tall shrub, commonly about 10 feet high, blooming in April and May, and inhabiting some of the woods of Scotland.—The woolly willow, *S. lanata*, is an ornamental undershrub, commonly about 2 feet high, blooming in May, and inhabiting some of the Scottish mountains.—The sand willow, *S. arenaria*, is a small shrub, commonly about 3 feet high, blooming in May and June, and inhabiting some of the lofty mountains of Scotland.—The silvery-sand willow, *S. argentia*, is a small ornamental shrub, commonly about 5 feet high, blooming in May, and inhabiting the sandy shores of Britain.—Dickson's willow, *S. Dicksoniana*, is an undershrub, commonly about 1 foot high, blooming in April, and inhabiting some of the lofty mountains of Scotland.—The small-leaved willow, *S. parvifolia*, is an ornamental undershrub, commonly about 2 feet high, blooming in April and May, and inhabiting the moist heaths of England.—The ascending willow, *S. ascendens*, is a curious minute undershrub, commonly about 5 or 6 inches high, blooming in April and May, and inhabiting the moist heaths of England.—Don's willow, *S. Doniana*, is a tall bush, commonly about 6 or 7 feet high, blooming in May, and inhabiting some of the Scottish mountains.—The rosemary-leaved willow, *S. rosmarinifolia*, is an undershrub, commonly about 2 feet high, blooming in April and May, and inhabiting sandy soils in various parts of Britain.—The marsh willow, *S. uliginosa*, is an undershrub, commonly about 2 feet high, blooming from April till June, and inhabiting the moist woods of Britain.—The cotinus-leaved willow, *S. cotinifolia*, is an undershrub, commonly about 2 feet high, blooming in April, and inhabiting some of the woods of Britain.—The olive-leaved willow, *S. oleifolia*, is an ornamental shrub, commonly about 4 feet high, blooming in March, and inhabiting some of the thickets of Britain.—The withered-pointed willow, *S. sphacelata*, is an undershrub, commonly about 2 feet high, blooming in April and May, and inhabiting some of the lofty mountains of Scotland.—Stuart's willow, *S. Stuartiana*, is a shrub of commonly about 4 feet in height, blooming in July and August, and inhabiting some parts of the Scottish Highlands.—The silky-rock willow, *S. rupestris*, is an ornamental shrub, commonly about 3 feet high, blooming in April, and inhabiting some parts of the Scottish Highlands.—Anderson's willow, *S. Andersoniana*, is a shrub, commonly about 3 feet high, blooming in April and May, and inhabiting some of the mountains of Scotland. All the species enumerated in this paragraph have villous leaves.

The netted willow, *S. reticulata*, is a similar curiosity to the herbaceous willow, having a height of only 5 or 6 inches, and having smooth entire leaves, blooming in June and July, and inhabiting some of the lofty mountains of Bri-

tain.—The slenderer willow, *S. tenuior*, is a small tree, commonly about 15 or 18 feet high, blooming in May, and inhabiting the banks of some of the Scottish rivers.—The rusty-leaved willow, *S. ferruginea*, is a tall shrub or small tree, commonly about 12 feet high, blooming in April, and inhabiting the hedge-rows and hedge-banks of various parts of Britain.—Woolgar's willow, *S. Woolgariana*, is a tall shrub or small tree of about the same height and blooming about the same period as the preceding, and inhabiting the banks of some of the English rivers.—The rock willow, *S. petræa*, is a tall shrub, commonly about 7 or 8 feet high, blooming in April and May, and inhabiting rocky grounds in various parts of Britain.—The phillyria-leaved willow, *S. phillyreæfolia*, is a curious shrub, commonly about 5 feet high, blooming in April, and inhabiting some glens and valleys in the Scottish Highlands.—The loose-flowered willow, *S. laxiflora*, is a tall shrub or small tree, commonly about 12 feet high, blooming in April, and inhabiting moist grounds in various parts of Britain.—The thin-leaved willow, *S. tenuifolia*, is a tall shrub or small tree, commonly about 12 feet high, blooming in April, and inhabiting some of the moist meadows of England.—The damson-leaved willow, *S. damascena*, is a tall shrub or small tree, similar in height and in the period of blooming to the preceding, and inhabiting some of the uplands of Britain.—And the ambiguous willow, *S. ambigua*, is a small ornamental shrub, blooming in April and May, inhabiting some of the grassy heaths of England, and comprising several varieties both indigenous and exotic.

The hastate or halbert-leaved willow, *Salix hastata*, is one of the best and longest known of the exotic kinds for both ornamental and economical purposes. It is a native of Lapland and Switzerland; and was introduced to Britain from the former of these countries in 1780. It commonly attains a height of about 15 feet; but is capable of becoming a middle-sized tree; and it also sends forth from its stools several long green shoots, which, though full of pith, are tough and serviceable to the basket-maker. Its leaves are nearly oval, acute, serrated, and smooth, and they sit close to the branches, and have broad appendages at their base; and its flowers grow in long yellow catkins, and come out in spring from the sides of the young shoots, almost their whole length.—An exotic species, called the serrulate willow, and the two indigenous species, called the apple-leaved and the little-tree willows, are regarded by some botanists as mere varieties of the hastate willow.

The Babylonian willow or weeping willow of Babylon, *Salix babylonica*, is by far the most ornamental kind of willow known, and, in certain situations, possesses more true elegance than any other plant whatever. It is a native of various oriental countries, and was introduced to Britain from the Levant in 1692; but it is sufficiently hardy to be successfully raised in any ordinary moist soil in a low or comparatively sheltered situation. It commonly attains a height of about 30 feet, and can easily be coaxed up to the bulk and altitude of a pretty large tree. It adorned the banks of the Euphrates in the days of the prophet Daniel, and has been rendered venerable by its association with the captivity of Judah, and with the language of one of the inspired psalms; and it is the most proper of all plants for any decorated spot by the side of a river, pond, or spring, which requires a combination of sadness and beauty; and when hanging over a rock, jutting from a promontory, or reclining over an urn, it is both pleasingly melancholy and inexpressibly beautiful. Its branches are slender, and very long and pendulous, and hang streaming in the air, and very easily admit of being twined and woven into garlands; its leaves also are long and narrow; and after a fall of mist or of rain, drops of water hang at the ends of the leaves, and combine with the pendulousness of the branches to give the plant a singularly weeping appearance.—Two plants somewhat nearly akin to the Babylonian willow are regarded by some botanists as varieties of it, and by others as separate species,—the one called the ring-leaved or curl-leaved willow, of doubtful origin, and occurring only in gardens,—and the other called Napoleon's weeping willow, a somewhat tender evergreen, introduced in 1823 from St. Helena.

WILLOW-HERB,—botanically *Epilobium*. A genus of plants of the order Onagrariæ. Nine species grow wild in Britain, upwards of a dozen have been introduced from other countries, and a few more are known. One of those in Britain is an annual, one is a very aquatic perennial, two are evergreen herbs, and the rest are perennial-rooted annual-stemmed herbs. One of the evergreens is tender, and all the other species are hardy. The leaves of all the indigens are simple, and those of most toothed; and the flowers of most of the species are either purple, pink, or red,—and those of most grow in terminal leafy clusters or in spikes. Some of the species have a weedy appearance; but others are decidedly ornamental,—and a few are highly beautiful. Most thrive well in any common soil, and are easily propagated by radical division; and indeed the best known and most common one in gardens, the narrow-leaved, is notorious for such a powerful habit of self-propagation by means of decurrent, subterranean, root-like stolons, that when it once gets fair possession of a few inches of ground, it cannot be exterminated without excessive care and labour.

The narrow-leaved or rose-bay willow-herb, *Epilobium angustifolium*, is a native of meadows and moist shady places, chiefly in the north of England. It is an annual-stemmed perennial of commonly between 3 and 6 feet high; and usually grows in fasicles, with a number of stems arising from congeries of roots or stolons. Its

root is fleshy, and rapidly decurrent, and powerfully stoloniferous; its stems are erect, cylindrical, reddish, smooth, leafy, and seldom branched; its leaves are numerous, scattered, almost sessile, linear-lanceolate, acute, veiny, smooth, and of various breadth; and its flowers grow in long terminal clusters, and have a crimson-purplish colour, and are numerous and very showy and handsome, and bloom in July and August. This plant is a great and general favourite in all sorts of flower-gardens, particularly in those of careless or slovenly cultivators; and it thrives, and takes care of itself, and freely propagates, in almost all sorts of soils and situations, even in the smoky air and choked flower-plots of the largest cities. A variety of it called the white, *E. a. album*, has white flowers, but occurs only in gardens.

The great hairy willow-herb, or codlings and cream, *E. hirsutum*, abounds in such watery places as ditches and the margins of rivers, among reeds, coarse aquatic grasses, and willows, in many parts of Britain. It is a true and even splashy aquatic, yet possesses an ornamental character, and thrives more or less on any common soil; and it is all over downy, soft, and clammy, and exhales a transitory, peculiar, acidulous odour, very similar to the flavour of boiled codlings and cream. Its root is extensively creeping; its stems are cylindrical, leafy, abundantly branched, bushy, and from 3 to 6 feet high; its leaves are half-clasping, ovate-lanceolate, and hairy; and its flowers grow in leafy corymbose clusters, and are large, and have a delicate purplish-pink colour, and bloom in July and August. A variety of it, *E. h. variegatum*, occurs wild with variegated leaves and rose-coloured flowers.

The small-flowered willow-herb, *E. parviflorum*, inhabits watery places in many parts of Britain, and has a highly ornamental character; and it commonly attains a height of about 3 feet, and carries purple-coloured flowers in July and August.—The square-stalked willow-herb, *E. tetragonum*, is a weedy-looking native of the marshes of Britain, and has a height of about 2 feet, and carries purple flowers in July.—The mountain willow-herb, or broad smooth-leaved willow-herb, *E. montanum*, is a weedy-looking native of the woods of Britain, and has a height of about 2 feet, and carries purple flowers in June and July.—The rose-coloured willow-herb, or pale smooth-leaved willow-herb, *E. roseum*, is a slightly ornamental inhabitant of the marshes of England, and has a height of about 18 inches, and carries pink flowers in July.—The marsh willow-herb, or round-stalked marsh willow-herb, *E. palustre*, is a weedy-looking inhabitant of the marshes of Britain, and has a height and appearance and time of blooming similar to the square-stalked species.—The alpine willow-herb, *E. alpinum*, is a small evergreen inhabitant of the margins of the lofty upland streams of Britain, and has a height of only 2 or 3 inches, and carries red flowers in June.—The chickweed-leaved willow-herb, *E. alsinifolium*, is a weedy-looking native of the Scottish Highlands, and has a height of about 6 inches, and carries pink flowers in July.

WILLOW-OAK. See Oak.

WILLOW-WEED,— botanically *Polygonum Lapathifolium*. An annual British weed, common on dunghills, rich loose deep soils, and some marshy lands in many parts of England, but scarcely or not at all known in clay districts or on turnip lands. Its stalks are tender, succulent, and pale, spotted, or reddish, and have very swollen joints, and commonly attain a height of about 12 or 18 inches; its leaves resemble those of the common willows, but are marked in the middle with dark spots; its flowers have a herbaceous colour, and bloom from June till September; and its seeds are very bright and heavy, and amount to vast numbers in favourable situations, and are highly nutritious, and are very grateful to partridges and other birds. This weed is one of the rankest, and most cumbersome, in the English fen districts, and is always a great robber of the soil wherever it grows, and makes a large contribution of seeds to infest samples of wheat, oats, and barley on corn lands; yet it serves well as a decoy for attracting wild ducks and some similar fowls, and might be made to contribute its seeds in a boiled state to the feeding of hogs. Other popular names for it than willow-weed are snake-weed, dockleaved knotgrass, and pale-flowered persicaria; though these names probably confound it with other native polygonums.

WIND. A sensible current in the atmosphere. The motions of the atmosphere are subject, in some degree, to the same laws as those of the denser fluids. If we remove a portion of water in a large reservoir, we see the surrounding water flow in to restore the equilibrium; and, if we impel in any direction a certain portion, an equal quantity moves in a contrary direction, from the same cause; or if a portion, being rarefied by heat, or condensed by cold, ascends in the one instance and descends in the other, a counter-current is the visible and natural result; and similar effects are found to follow the same causes in the atmospheric fluid: thus no wind can blow without a counter or opposite current; nor can any wind arise without a previous derangement of the general equilibrium, the general causes of which may be stated as follows: 1. The ascent of the air over certain tracts heated by the sun; 2. evaporation, causing an actual increase in the volume of the atmosphere; 3. rain, snow, &c., causing an actual decrease in its volume, by the destruction of the vapour. In the 'Philosophical Transactions of the Royal Society of London' (vol. 51st), there is a table of the different velocities and forces of winds, drawn from a considerable number of facts and experiments, which give the following results:—

Velocity of the Wind. Miles per Hour.	Feet per Second.	Perpendicular Force on one square Foot in Avoirdupois Pounds and Parts	
1	1.47	·005	Hardly perceptible.
2	2.93	.020	Just perceptible.
3	4.4	.044	
4	5.87	.079	Gently pleasant.
5	7.33	.123	
10	14.67	.492	Pleasant, brisk.
15	22.	1.107	
20	29.34	1.968	Very brisk.
25	36.67	3.075	
30	44.01	4.429	High wind.
35	51.34	6.027	
40	58.68	7.873	Very high wind.
45	66.01	9.963	
50	73.35	12.300	Storm or tempest.
60	88.02	17.715	Great storm.
80	117.36	31.490	Hurricane.
100	146.7	49.200	Hurricane that tears up trees, and carries buildings before it.

Currents thus produced may be permanent and general, extending over a large portion of the globe; periodical, as in the Indian ocean, or variable and occasional, or, at least, uncertain, as the winds in temperate climates. General or permanent winds blow always nearly in the same direction, and are called *trade-winds*. On the north of the equator, their direction is from the north-east (varying at times a point or two of the compass each way): on the south of the equator, they proceed from the south-east.—See Anemometer, Weather, and Calendar.

WIND. The breathing of any animal, particularly of the horse. The most effectual method of bringing a horse into the peculiarly healthy habit of breathing technically called good wind, is to give him regular exercise, to increase very gradually the amount of exercise, to give him oats and good hay in quantity proportioned to his exercise, to make his allowance of hay at all times moderate, to give him water in moderate quantity three times a-day, to keep his stable in a clean and well-ventilated condition, and to give him occasionally or when needed a dose or two of mild physic. The nature and varieties and proper treatment of morbidity in a horse's habit of breathing are treated in the articles Broken Wind, Thick Wind, and Pneumonia.

WIND-FLOWER. The marsh gentian and the anemone. See the articles Gentian and Anemone.

WIND-GALLS. Elastic tumours on each side of the back sinews of the horse, immediately above the fetlock joint. They are generally caused by hard work at too early an age; and they arise from excessive secretions of the synovial fluid, which lubricates the joints and bony prominences of the limbs. They are called *bursæ mucosæ* by scientific veterinarians; but both this name and the popular one are misnomers; for they contain neither mucus nor wind, but are simply enlarged capsules of synovia. They seldom occasion much suffering or inconvenience, and can scarcely be regarded as decided indications of unsoundness; but are commonly slow, chronic, painless enlargements. They may be partially subdued by means of blisters, stimulating liniments, firing, or appliances of any kind for promoting the absorption of their contents; but they are best dealt with by the mere pressure of bandage,—or at the utmost by the combination of this with an evaporating lotion; and never ought they, according to the practice of the old farriers, to be opened and surgically evacuated,—for the laying of them open occasions almost as much irritation and danger as if the joint itself were to be perforated.

WINDMILL. A mill whose moving power is the wind. It is fitted with arms, vanes, or sails, for catching the breeze, and may have them either vertically or horizontally, and admits of a considerable diversity of both structure and adaptation. Windmills with vertical sails are the best; but even they, no matter how well constructed or how advantageously situated, are far inferior, in aggregate value, to water-mills or steam-mills, and are not equal, in some cases, to even horse-mills or hand-mills. They suit tolerably well on only exposed spots, where every current in the air can be caught; and even there they have the incurable defect of being perfectly useless in calm weather, and sometimes therefore at a season when mill-work is most wanted, and cannot without loss and great inconvenience be postponed. Mr. Ferguson calculated the velocity of the sails of a windmill, in a moderate wind, to be 30 miles per hour.

As a horizontal windmill consists of vertical sails moving horizontally round a vertical arbour or windshaft, no motion would arise on exposing it to the action of the wind, as the effect of the wind upon the sails on one side would be counterbalanced by its action upon the corresponding sails on the opposite side. Hence it is necessary either to screen the sails on one side from the action of the wind, or to construct the sails in such a manner that, when they return against the wind, they present only their edge to its action. The method of screening the returning sails from the wind is adopted in Tartary and some provinces of Spain, and is the most simple that has been tried. When the screen is not used, the sails may be fixed like float-boards, with hinges, on the circumference of a large drum or cylinder, so that, when they are to receive the action of the wind, they stand at right angles to the drum, and when they turn against the wind, they fold down upon its circumference. Other ingenious methods have also been devised for bringing back the sails against the wind. In the vertical windmill, on the other hand, the arms which carry the sails revolve in a plane facing the wind. In this arrangement, if the sails were in the same plane with the arms, the wind would fall perpendicularly upon them, and merely press the arms against the building, perpendicular to the plane in which they are designed to move. If, on the other hand, the sails were perpendicular to the plane in which the arms move, their edges would be presented to the wind, and would, therefore, offer no resist-

ance, and there would be no motion. In order to make the arms revolve, the sails must, therefore, be placed in some direction intermediate between those of the wind and the plane in which the arms revolve. In determining the angle at which the planes of the sails should be inclined to the axis of motion, or the direction of the wind, it is necessary to consider the sail in motion; and the neglect of this element in the calculation has led to very great errors in theoretical calculations. The sail being in motion, the velocities of the sail and the wind must both be taken into account; for, if the sail moved before the wind with a speed equal to that of the wind itself, no effect would be produced. The effect will depend on the difference of the velocities, that being the velocity with which the wind strikes the sail. Now, as the obliquity of the sail to the wind should depend on the force with which the wind acts upon it, and as those parts of the sail which are nearer to the centre of motion move more slowly than those which are more remote, it follows that the position of the sail should vary at different distances from the centre of rotation. From the experiments of Mr. Smeaton on this subject (Philosophical Transactions, 1759), it appears that the following positions are the best. Suppose the radius to be divided into six equal parts, and call the first part, beginning from the centre, one, the second two, and so on, the extreme part being six:—

No.	Angle with the Axis.	Angle with the Plane of Motion, or Angle of Weather.
1	72°	18°
2	71	19
3	72	18
4	74	16
5	77½	12½
6	83	7

As it is necessary that a windmill should face the wind from whatever point it blows, the whole machine, or a part of it, must be capable of turning horizontally. Sometimes the whole mill is made to turn upon a strong vertical post, and is therefore called a *post mill;* but, more commonly, the roof or head only revolves, carrying with it the windwheel and its shaft, the weight being supported on friction rollers. In order that the wind itself may regulate the position of the mill, a large vane, or weathercock, is placed on the side which is opposite the sails, thus turning them always to the wind. But in large mills the motion is regulated by a small supplementary windwheel, or pair of sails, occupying the place of the vane, and situated at right angles with the principal windwheel. When the windmill is in its proper position, with its shaft parallel to the wind, the supplementary sails do not turn. But when the wind changes, they are immediately brought into action, and, by turning a series of wheelwork, they gradually bring round the head to its proper position.

On account of the inconstant nature of the motion of the wind, it is necessary to have some provision for accommodating the resistance of the sails to the degree of violence with which the wind blows. This is commonly done by clothing and unclothing the sails; that is, by covering, with canvass or thin boards, a greater or smaller portion of the frame of the sails, according to the force of the wind at different times. A method has been devised for producing the same effect, by altering the obliquity of the sails; and windmills have been so made as to regulate their own adjustment by the force of the wind. If we suppose a windmill, or windwheel, to consist of four arms, and that the sails were connected to these arms at one edge by means of springs, the yielding of these springs would allow the sails to turn back when the wind should blow with violence; and their elasticity would bring them up to the wind whenever its force abated. This effect has been produced by a weight acting on the sails through a series of levers. A loose iron rod, passing through the centre of the axle of the windwheel, receives the action of the weight at one end, and communicates it to the sails at the other. See the articles Mill and Thrashing-Machine.

WINDPIPE. The trachea or grand air-passage to the lungs of animals. It comprises the most admirable adaptations to the joint properties of flexibility and permanent tubularity; and is beautifully suited, in form and capacity, to the precise wants and habits of each species; and it is lined with a very vascular mucous membrane to supply all its interior surface with a secretion for defending it against the irritating effects of diversified temperature in the air. The windpipe of the ox comprises 8 or 10 more cartilaginous rings than that of the horse, or altogether about 60; but it is smaller in diameter, looser in construction, and weaker in the interposed ligamentous substance,—and it also exhibits other differences, involved in its perfect adaptation to the ox's habits.

WINDROW. The green part or border of a field dug up in order to furnish material for ameliorating the rest of the land,—and is called a windrow because it is laid in rows and exposed to the wind. A windrow is also a particular kind of heap or collecting of hay in the process of haymaking; and is likewise a row of peats in the process of cutting turbary for fuel,—and a row of turf in the process of georgical improvement by paring and burning.

WINE. Any fermented vegetable juice which contains sugar and an acid. All the truest wines consist of the fermented juice of the grape; but inferior wines may consist of the fermented juice of various other fruits, or even of the fermented juice of some leaves and stems. The chemical process by which the juice passes into wine is described in the article Fermentation; and the kinds of grape used for making the best wines are described in the article Grape-Vine.

The History of Wines.—The discovery or in-

vention of wine is enveloped in great obscurity, but must be referred to very remote times. The first portion of grape-juice which had been pressed out by accident or design, and allowed to remain a short time undisturbed, would be found to have assumed new and surprising properties; and repeated trials would soon prove the value of the discovery. By degrees, the method would be learned of preserving for constant use the beverage so obtained; and various processes would gradually be resorted to for enhancing its grateful qualities. The knowledge of the art would rapidly spread; and its simplicity would recommend its universal adoption. The Egyptians gave the honour of the discovery to Osiris, the Latins to Saturn, and the Greeks to Bacchus; while various authors have assigned it to other persons, not certainly so celebrated as the fabulous individuals just named, but not the less likely to merit the honour. Yet all these persons, or any of them, were probably mere improvers or early manufacturers of the beverage; and the real inventor or discoverer was either Noah or some one of the antediluvians. "Noah," says the inspired record, "began to be an husbandman, and he planted a vineyard, and he drank of the wine." From the manner of this passage, it is not unlikely that the art of wine-making had been known to the antediluvians; but, however this may be, it is mentioned in many a page of the sacred volume as quite commonly practised after the flood. "Corn and wine" seem to have been equally abundant, and are mentioned in the Old Testament as rather the necessaries and comforts than the luxuries of life. But though vineyards were cultivated to so great a degree in Palestine, wine seems not to have been so common in other countries. Indeed the quantity produced elsewhere was for a long time very small. Except in Egypt and Greece, wine was seldom allowed either to virgins, to matrons, or to young men. In Rome, most severe restrictions were laid on it for the first 200 years of that celebrated city. But about this period, that is 500 years before the Christian era, it began to be manufactured in greater abundance; and when afterwards the Romans carried the cultivation of vineyards to the greatest extent to which they ever reached, their productiveness was incredible, exceeding that of modern vineyards by about a half. The varieties of the vine, known to the ancients, were very numerous, amounting to about fifty; and some of them are described with sufficient minuteness to enable us to appreciate the relation in which they stand to our modern vines. Wine, however, was generally designated, not by the species of vine from which it was produced, but generally from the place where it was manufactured; thus we read of *Vinum Falernum, Massicum, Albanum, Chium, Rhodium, Maeonium*. Sometimes it obtained its name from its colour or age, as *Vinum album, nigrum, rubrum, vetus, hornum, trimum*.

The Chemical Constitution of Wines.—The essential components of all wines—irrespective of the water which forms their basis and of the various substances which constitute their differences and peculiarities—are one or more acids, a volatile oil or oily ether, extractive matter, colouring matter, and alcohol. The acids vary widely in kind, number, and quantity, according to the various nature of the juices; the oil or ether contains the flavour or aroma or bouquet, and is exceedingly richer in the prime wines than in the inferior; the extractive matter abounds far more in new wines than in old, and is mightily controlled in kind, quantity, and condition, by all the circumstances of the vintage; and the alcohol is the most important of the ingredients, and surmounts and modifies them all for dietetical and medicinal uses, and does not, as is often supposed, lie latent till formed by distillation, but comes necessarily and fully out of the process of vinous fermentation, and therefore exists essentially in all wine, and distinguishes it from must or mere vegetable juice. Saccharine matter, gluten, and acid are indispensable in any juice in order to its forming wine; and the quantity of the first, the kind of the last, and the amount of mutual reaction between the first and the second, contribute more than all the other ingredients and circumstances to determine or form the wine's character. When the saccharine matter is very abundant, a checked fermentation renders the wine sweet and luscious, and a brisk and exhausting fermentation renders it strong and spirituous; and when the saccharine matter exists in small quantity, especially if malic or citric acid rather than tartaric be predominant, the wine is thin and weak. When tartaric acid abounds in the must, the wine ought to be highly flavoured and long-keeping; when carbonic acid is voluminously developed in the fermentation, the wine ought to be brisk and sparkling; and when the acids of the must largely survive the fermentation, so as to continue free or uncombined, the wine ought to be light and dry.

The taste and smell which distinguish good grape wines from all other fermented liquids depend upon an ether of an oily nature,—the ether of a volatile and highly combustible acid,—called œnanthic ether. This is formed by deoxidation of the substances held in solution in the must; and contains the same proportions of carbon and hydrogen as sugar, but a far less proportion of oxygen. "The wines of warm climates," remarks Liebig, "possess no odour; wines grown in France have it in a marked degree; but in the wines from the Rhine the perfume is most intense. The kinds of grapes on the Rhine which ripen very late, and scarcely ever completely, such as the Riessling and Orleans, have the strongest perfume or bouquet, and contain proportionally a larger quantity of tartaric acid. The wines from the earlier grapes, such as the Rulander, and others, contain a large proportion of alcohol,

and are similar to Spanish wines in their flavour, but they possess no bouquet. The grapes grown at the Cape from Riesslings, transplanted from the Rhine, produce an excellent wine, which does not, however, possess the aroma peculiar to the Rhenish wine. It is evident, from these facts, that the acid of wines, and their characteristic perfumes, have some connexion, for they are always found together; and it can scarcely be doubted that the presence of the former exercises a certain influence on the formation of the latter. It is only in liquids containing other very soluble acids, that the fatty acids and œnanthic acid are capable of entering into combination with the ether of alcohol, and of thus producing compounds of a peculiar smell. This ether is found in all wines containing a free acid, but is absent from those in which no acids are present. This acid, therefore, is the means by which the smell is produced; since without its presence œnanthic ether could not be formed. On the Rhine, also, an artificial bouquet is often given to wine for fraudulent purposes, by the addition of several species of the sage and rue to the fermenting liquor; but the fictitious perfume thus obtained differs from the genuine aroma, by its inferior durability, and by being gradually dissipated. The juice of grapes grown in different climates differs not only in its proportion of free acid, but also in respect of the quantity of sugar dissolved in it. The quantity of azotised matter in the juice seems to be the same in whatever part the grapes may grow; at least, no difference has been observed in the amount of yeast formed during fermentation in the south of France, and on the Rhine. The grapes grown in hot climates, as well as the boiled juice obtained from them, are proportionally rich in sugar. Hence, during the fermentation of the juice the complete decomposition of its azotised matters, and their separation in the insoluble state, are effected before all the sugar has been converted into alcohol and carbonic acid. A certain quantity of the sugar consequently remains mixed with the wine in an undecomposed state, the condition necessary for its further decomposition being absent. The azotised matters in the juice of grapes of the temperate zones, on the contrary, are not completely separated in the insoluble state, when the entire transformation of the sugar is effected. The wine of these grapes, therefore, does not contain sugar, but variable quantities of undecomposed gluten in solution. This gluten gives the wine the property of becoming spontaneously converted into vinegar, when the access of air is not prevented; for it absorbs oxygen and becomes insoluble, and its oxidation is communicated to the alcohol, which is converted into acetic acid. By allowing the wine to remain at rest in casks with a very limited access of air, and at the lowest possible temperature, the oxidation of this azotised matter is effected without the alcohol undergoing the same change, a higher temperature being necessary to enable alcohol to combine with oxygen. As long as the wine in 'the stilling-casks' deposits yeast, it can still be caused to ferment by the addition of sugar; but old well-cleared wine has lost this property, because the condition necessary for fermentation, namely, a substance in the act of decomposition or putrefaction, is no longer present in it. In hotels and other places where wine containing much gluten is drawn gradually from a cask, and a proportional quantity of air necessarily introduced, its eremacausis, that is, its conversion into acetic acid, is prevented by the addition of a small quantity of sulphurous acid. This acid, by entering into combination with the oxygen of the air contained in the cask, or dissolved in the wine, prevents the oxidation of the organic matter."

Many of the wines of commerce contain ingredients or principles altogether foreign to their proper nature,—added to them for the purpose of adulteration, of concealing their bad properties, or of improving their odour or colour or taste. Such flavouring substances as orris root, bitter almonds, nitrous ether, oak chips, wormwood, and white leather are very extensively used for white wines; such colouring substances as common red and brown dye-stuffs, logwood, Brazil wood, elder berry, and iron are profusely used for red wines; such poisonous substances as litharge and white lead are not unfrequently used for correcting the acidity of wines which have become sour; and such terribly murderous substances as arsenic and corrosive sublimate have sometimes been used in the process of fining. Liquid potash precipitates the natural principles of wine green, and therefore serves as a good test for promptly ascertaining whether any specimen of the wines of commerce be an artificial mixture; and a few drops of the prussiate of potash throw down a whitish precipitate in any specimen which contains a salt of lead, and therefore readily detect the presence of litharge or white lead.

The Manufacture of Wines.—When the grapes are ripe, and have attained their sweetest or most saccharine state, the juice, then called the must, is pressed out of them, and put into suitable vessels for undergoing fermentation. "When the must is exposed to the temperature of 65° of Fahrenheit's scale," says Dr. Henderson, in his History of Ancient and Modern Wines, "it speedily begins to ferment. Small bubbles first collect on the top, and may be seen gradually issuing from the central parts of the liquor, and bringing up the husks, stones, and other grosser matters which it contains. As the disengagement of gas proceeds, a hissing noise is produced by the bursting of the bubbles; and a frothy crust or scum is formed by the viscid particles which they have carried to the surface. An increase of the temperature and bulk of the fermenting mass now takes place; the must loses its original consistency and its saccharine taste, acquiring a deeper colour and a vinous flavour, with an odour of

spirit of wine, which becomes more perceptible as the process advances. At length these commotions of the fluid abate spontaneously; and, after a few hours rapid fermentation, the ebullition ceases altogether, the mass subsides to its former bulk, and the crust and solid particles which disturbed the transparency of the liquor, are precipitated to the bottom of the vessel." In order to insure a regular and complete fermentation, it is necessary that the grapes should be all equally trodden, and that the vat which is to contain them should be filled as speedily as possible; within twenty-four hours at farthest. Fermentation proceeds with incredible rapidity, insomuch that the juice, as it flows from the grape, will often work and ferment before it arrives at the vat, owing to the pressure and motion to which, when being carried from the vineyard, it has been subjected. The most favourable temperature, as already stated, is 65° of Fahrenheit. Below that degree, fermentation is languid; above, it is violent; and when very high or very low, it ceases altogether. When the process has commenced, however, the temperature quickly rises, even so high as 30° above the point in question. Another circumstance necessary to fermentation is contact with the external air: without this, indeed, no fermentation can take place; but after the process has been established, such contact is not necessary. Finally, fermentation is brisk in proportion to the extent of the fermenting mass; so that in a cask it proceeds more slowly than in a vat. When, from any cause, fermentation does not go on successfully, means must be used to supply the defect. If, for example, the must is too thin and watery, and fermentation proceeds with difficulty, the objection may be removed by one of three ways,—either by boiling the must and allowing the superabundant water to evaporate,—or by merely throwing in a portion of must which has been thus thickened,—or by adding a quantity of sugar, as is the common practice in cold climates where the grapes seldom reach their full maturity. In some places baked gypsum is used, in order to absorb the excess of humidity; in others, the grapes are partially dried before they are trodden. The addition of tartar accelerates fermentation, particularly if the grapes abound in the saccharine principle. The stalks of the grapes, when added to the mash, act as a powerful leaven, and augment the strength of the wine; but to the weaker sort, they are apt to communicate a harsh and austere flavour, owing to the tannin and extractive matter which they contain. In the case of port they are always used; while in the manufacture of the more delicate red wines of Bourdeaux, they are generally excluded. For the white wines of the same district, however, they are thought to be advantageous, rendering them less apt to spoil. Yet the wines of the Rhine, which are distinguished by their great durability, are not fermented with the stalks, and would probably not bear the addition. The exact time required to complete fermentation varies, being dependent on the quality of the grapes and of the wine sought to be obtained. Weak wines require but a short time; the lighter wines, in truth, will not bear the vat longer than from twenty to thirty hours. If a brisk wine is wished, the contents of the vat must be drawn out into casks before the fermentation subsides. In general, the process may be regarded as terminated, when the saccharine flavour of the must has disappeared and the liquor has acquired a distinct vinous taste. —In transferring the wine from the vat to the cask, it undergoes a new process, which renders it again turbid, and generates the phenomena that marked the former action. A portion of the sugar, though the taste of it has nearly disappeared, remains undecomposed; and this being acted upon by the mucilaginous extractive matter which still exists in solution, a disengagement of carbonic acid gas, and a fresh deposit of sediment, will be the result. These movements become by degrees less perceptible; but still there goes on an insensible fermentation, as it is called, which, particularly in the case of the stronger wines, will continue for many years,—during which they become much ameliorated. A portion of the colouring matter and tartar is precipitated; the liquor loses its harshness; and the aroma and flavour that are peculiar to it become more apparent. These changes may be accelerated by various artificial methods, especially by the agitation of the lees, which always contain a quantity of fermentative matter, and by the assistance of heat. Hence the reason why certain strong and austere wines are so much improved and mellowed by being exported on the lees to a warm climate, while the lighter and more delicate wines are generally injured by being made to undergo a similar process, or even by the motion occasioned by the removal of them to any considerable distance.— The next step, when wine has attained a sufficient degree of maturity, is to free it from the lees by being racked, as it is termed, into a clean cask; and in order to prevent a renewal of fermentation, it is subjected to the operation of sulphuring. This process is generally performed by means of sulphur matches applied to the cask into which the wine is to be racked. Should the fermentation still continue, this application is renewed as often as may be necessary. Sometimes must, strongly impregnated with sulphurous acid gas, is added to the wine, which answers the same purpose as the other mode. After sulphuring, the greater proportion of wines require to be farther clarified, or 'fined,' before they attain a due brightness. For this purpose various substances are used, which, by their chemical or mechanical action, unite with such materials as disturb the purity of the wine, and precipitate them to the bottom. The substances

in general use are isinglass and the white of eggs; but as these, particularly in warm climates, are of a putrescent nature, gum arabic has been used instead of them. In Spain the white wines are sometimes clarified with fuller's earth. Powdered marble, gypsum, heated flints, beechwood chips, and a variety of other things, are used for the same purpose. The quantity, however, of any of these substances used is very small; one ounce of isinglass, for example, is sufficient for a hundred gallons of wine. Brandy is sometimes mixed with wine; and different wines are as frequently mixed with each other;—processes which require great attention and nicety.

The manufacture of French champagne, the finest of all brisk wines, may be selected for particular detail, both because it comprises the utmost niceties of the general process of wine-making, and because it very distinctly shows the production of a lively creaming wine to depend upon the expulsion of a certain portion of the yeast by overflow from the vent-hole, so as to leave in the liquor a preponderance of undecomposed saccharine matter. And this is described as follows by MacCulloch, in his Treatise on Wine-Making:—"The grapes are first squeezed by a gentle pressure, and poured into the vat, where they remain for one night only. The next morning the liquor is transferred into casks. If the wine is intended to be red, the fermentation is allowed to continue some time longer on the husks, till the red colour has been extracted; but the seeds are carefully separated, as they communicate a harsh taste. The first fermentation in the casks is violent, and the discharge of the yeast is encouraged for ten or twelve days, by keeping them full to the bung-hole. It then becomes more moderate, when the bung is put down, and a gimlet-hole, fitted with a spile, is made by the side of it. When the cask is thus closed, the vent-hole is opened every day or two, according to the state of the fermentation, for a space of eight or ten days, to allow the carbonic acid to escape. When this state is passed, fresh wine, reserved for the purpose, is poured in at the vent-hole, about once a-week, for the first three or four weeks, according to its waste, so as to fill the cask. This operation is then performed at longer intervals, of a month or more, till the end of December, when the wine usually becomes clear. It is afterwards decanted from the lees into a fresh cask, where it is fined with isinglass, in the proportion of half an ounce to a pipe; and this process of decanting is carefully executed in dry clear frosty weather. A new fermentation is now excited, by which the wine loses a portion of its sweetness, and becomes still further meliorated. If it should prove too sweet, this first operation of decanting is not performed until the fermentation in the first cask has been rendered more vigorous, which is done by stirring up the lees, and rolling the pipe; and by this the sweetness is overcome, and the wine strengthened and improved. To insure the fineness of this wine, which is one of its essential properties, and to render it at the same time durable, it is at the end of six weeks decanted a second time into a fresh pipe, and once more fined with half the quantity of isinglass. It is then completed, and is put into bottles in March,—clear dry weather being also chosen for this purpose. Notwithstanding all this care, a fresh deposit is still formed in the bottles, from a renewal of the fermenting process, which goes on in them. To remove this, and to render the wines marketable, those of the best quality are decanted clear into fresh bottles in about fifteen or eighteen months, when the wine is perfected. A certain loss, amounting to one or two bottles in a dozen, is sustained, by their exploding previous to this last stage. Another process is sometimes adopted for getting rid of the sediment, without the trouble of decanting. In this mode, the bottles are reserved in a frame proper for the purpose during a certain number of days, so as to permit the foulness to fall into the neck. While in this position, the cork is dexterously withdrawn, and that portion of the wine which is foul allowed to escape, after which the bottles are filled with clear wine, permanently corked, and secured with wire and wax."

The manufacture of British wines from gooseberries, currants, cherries, oranges, apples, pears, and other fruits is so generally known, and is concerned with such comparatively poor beverages, that nothing needs be said respecting it. But the manufacture of wines from green or unripe British-grown grapes, and from the leaves and prunings of the plants of British vineries, is so limitedly known, and has been found to produce such comparatively excellent beverages, that some notes upon it may be acceptable to many readers; and happily some highly satisfactory ones lie ready at our hand, in a paper by a very intelligent writer, who speaks from both scientific knowledge and actual experiment,—Mr. Towers. "The must," says this writer, "cannot with safety be converted to a dry wine, unless its gravity be considerable, because the leaven will act energetically upon a light and weak fluid, decompose the sugar in a very short period, and cause the poor thin wine, which will be the result, to run speedily into the acetous fermentation. Therefore, to prepare a dry and keeping white wine from green, immature grapes, it will require an increased quantity of both materials; and the following receipt may with confidence be taken as a standard,—let the quantity be considered six gallons. Grapes bruised without crushing the seeds, 36 lb. to be digested with water in a pan or tub, covered at top with a flannel. The gravity of the liquid should be tried by a saccharometer or by the comparison of weights with pure rain or distilled water after the materials have stood together two hours,—again, after twelve hours,—and a third time

at the end of twenty-four hours. The water first added should be in quantity sufficient to cover and float the pulp; perhaps four gallons may be generally used. During some hours the gravity will increase; and while it does so, the materials should remain together, and be stirred five or six times. The temperature of the room might be about 55°; and the eye of the operator should be on the alert to discern, and his hand ready to arrest, the very minutest appearance of fermentation indicated by small groups of air bubbles. The liquor is to be strained off—the pulp squeezed or pressed,—and finally washed with more water,—strained and again pressed,—and its gravity noted down. We will state this gravity at 20 in 1,000 above water at 60°, *i. e.* at 1·020. The liquor should measure five gallons at the least; and to it may be safely added 15 lb. of good loaf-sugar, or 12 lb. of sugar, and 3 lb. of honey, which latter always tends to confer a soft and vinous character on the must. If the gravity do not rise to 1·120, more saccharine material (sugar or honey) must be added cautiously, till that density be acquired. Fermentation may then be suffered to take place quietly, without any extraneous aid, and be promoted by warmth and agitation if the weather be cold. The liquor should be retained in the tun or pan till the gravity be reduced to 1·085, at which it will have acquired a decidedly vinous odour. It will be understood that the fluid is to be made up seven gallons by water before the fermentation begins, always adding sugar till the gravity be found 1·120. This quantity will suffice to fill the barrel to within an inch of the bung-hole, leaving a reserve of nearly a gallon for filling up, after a fermentation is nearly completed; the reserve is to be kept apart, in a stone bottle, covered with a small piece of flat glass. The cask must be perfectly clean, sweet, and dry; it should be raised a few inches above the floor of a good arched cellar, the temperature of which remains pretty equable at all seasons. The wine must not throw off its yeast; it is to be agitated by rolling, or stirred with a clean stick let down through the bung-hole. This hole is subsequently to be covered over with a piece of tile or slate, placed over a grape leaf. After the hissing shall have subsided to a gentle fretting, the clearest portion of the reserved wine is to be poured into the barrel, when the hole may be partly closed, by fitting it loosely with a sound and clean bung. In order to afford an example of the progress of vinification, we extract from a journal the minutes of several observations made during the season of 1838:—Sept. 29. The materials used to prepare 6 imperial gallons of wine were—grapes 33 lb., 2½ lb. grape leaves or tips of shoots digested in 2 gallons of boiling-water, pressed when cold, and the liquor poured over the crushed grapes; 16 lb. of loaf-sugar, and the washings of a few clean honey-combs, after the honey had been drained from them; the gravity was at least 1·120, and the bulk of must was made up 7 gallons. Oct. 4. The gravity of green grape liquor or must after the fermentation had been established during a few hours, 1·115. Oct. 6. (Temperature of the room 50° to 55°), gravity 1·096. Oct. 8. (Idem), barrelled at noon, gravity 1·0840. The hissing continued regularly,—the bung was loosely fitted,—and the wine was permitted to be at rest, in a temperate cellar, till February 1839, when it was found quite clear, pale, and rich, but not luscious. April 1. The gravity was reduced, by throwing off carbonic acid, and the production of vinous alcohol, to 1·026; 30 grains of isinglass, dissolved in a pint of the wine, poured in as finings. April 6. Racked off, reserving the bright wine, and bottling the lees to settle. Cleaned the cask perfectly, adding half an ounce of powdered white marble, and one pint of old bucellas. Returned the clear grape-wine, and bunged the barrel. As it was not quite full, the wine reserved in bottles, which became bright as the lees precipitated, was poured into the barrel, in which it is intended that it shall remain till March 1840.

"The wine from the leaves, tender shoots, and tendrils of the vine, if judiciously prepared, is so excellent, that Mr. MacCulloch compared it to 'white hermitage.' The claret vine leaves, as he observes, will produce a red colour, and this tree could be cultivated for the express purpose. Having repeatedly prepared red and white leaf wine, we can with the greater confidence offer a few abbreviated extracts from Mr. MacCulloch's book, previously observing, that the specific gravity of the liquor must here also be taken as the criterion of strength; the proportions are calculated for ten gallons of wine. 'The leaves should not have attained their full growth, and must be plucked with their stems. On forty or fifty pounds of such leaves, seven or eight gallons of boiling water are poured, in which they are to infuse for twenty-four hours; the liquor being then strained off, the leaves are to be forcibly pressed. A gallon more water is to be added, and the leaves again are to be pressed. A screw wine-press, with hair bags, is very useful in this process. Sugar, varying from 25 lb. to 30 lb., is then to be added to the mixed liquors, the quantity is to be made up to ten gallons and a half.' Such are the essentials of Mr. MacCulloch's directions. We need only add that, if a fermenting, lively wine, be contemplated, the manufacture must be conducted as in the process for champagne, and the smaller of the two proportions of leaves, &c., is to be employed. The specific gravity of the must should be 1·110 to 1·115. The fermentation must be carried on for a short time in the open vessel, or till the gravity be reduced to 1·090; and the barrel will require to be filled, and be kept full, in order to carry off the froth and leaven that rise to the top of the liquor. But we apprehend that grape leaves are better qualified to produce a dry wine, and therefore the larger proportion of leaves, &c., should be employ-

ed, and sugar, to an extent that will raise the gravity to 1·120. In this case the fermentation must be conducted in the manner already stated for the production of a dry wine from green grapes; and when perfected, and the wine become bright, it is to be fined and racked off, during clear and cold weather, then returned to a clean and sweet cask, and bunged close. A second fining and racking may be required. Grape wine, made from the green berries, we have ever found delicious in flavour, and quite fit for the table in two years or less. But the liquor obtained from the leaves contains a quantity of vegetable extract, which conveys a flavour that time alone can subdue; hence, we recommend that it be always retained two years in the cask, and be bottled in the second winter. It also ought to remain during an entire year in the bottles."

The Varieties of Wine, and their Characteristics.—Port wine, according to Brande, contains 22·96 per cent. of alcohol of specific gravity ·825. It takes its name from Oporto, whence it is shipped; and it is produced in the province of Upper Douro, in Portugal, under a monopoly granted to the "Oporto Wine Company," in the year 1756. Dr. Henderson gives the following account of it:—"A certain extent of territory is marked out by its charter as the only district on the Douro in which wine is to be raised for exportation. The entire and absolute disposal of the wines raised in this district is placed in the hands of the Company; who are further authorized to fix the prices to be paid for them to the cultivators, to prepare them for exportation, and to fix the price at which they shall be sold to foreigners! It is obvious that a Company with such powers cannot be anything else than an intolerable nuisance. What could be more arbitrary and unjust than to interdict the export of all wines raised out of the limits of the Company's territory? But even in its own district, its proceedings have been most oppressive and injurious. The Company annually fix, by a fiat of their own, two rates of prices—one for the *vinho de feitoria*, or wine for exportation, and the other for *vinho de ramo*, or wine for home consumption—at which the cultivators are to be paid, whatever may be the quality of their wines! They have, therefore, no motive to exert superior skill and ingenuity; but content themselves with endeavouring to raise, at the least possible expense, the greatest supply of *vinho de feitoria*, for which the Company allows the highest price. All emulation is thus effectually extinguished, and the proprietors who possess vineyards of a superior quality, invariably adulterate their wines with inferior growths, so as to reduce them to the average standard. In this way the finer products of the Douro vintages have remained in a great measure unknown to us; the Port wine has come to be considered as a single liquor, if I may use the expression, of nearly uniform flavour and strength; varying, it is true, to a certain degree in quality, but still always approaching to a definite standard, and admitting of few degrees of excellence. The manipulations, the admixtures—in one word, the adulterations—to which the best wines of the Cimo do Douro are subjected, have much the same effect as if all the growths of Burgundy were to be mingled in one immense vat, and sent into the world as the only true Burgundian wine. The delicious produce of Romanée, Chambertin, and the Clos Vougeôt, would disappear, and in their places we should find nothing better than a second-rate Beaune or Macon wine." The quantity of Port wine consumed in England, annually, averages about 2,500,000 gallons. Before it leaves Oporto, a large quantity of brandy is always added. On its arrival it has a rough full body, with an astringent taste, and a strong flavour of the brandy. When kept a few years in the wood, these flavours are ameliorated; but in order to arrive at perfection, it should be laid down in bottle for several years; for during the process of ripening, a portion of the extractive and colouring matter is precipitated in the form of crust. There are processes by which the change and the ripening may be accelerated; but the substances used to effect this are more or less deleterious. In fact, although Port is such a favourite wine, there is no doubt but that nine-tenths of the quantity consumed has been adulterated, by one process or another, after its arrival in this country.

Sherry wine, of the dry prime kind called Amontillado, has a deep amber colour, and a nutty and aromatic flavour; and, according to Brande, contains 19·17 per cent. of alcohol. This is produced in a district of Spain called Xeres, in the neighbourhood of Cadiz. Since the reduction of duty in 1825, the consumption of Sherry is nearly as great as Port, and has more than doubled its former extent. This is an excellent dinner-wine when ripe; but it requires to be kept four or five years in the wood, and double or treble that period in bottle, before it attains its full bloom. The adulteration practised in it is immense, owing to the facility afforded by the cheap and inferior Cape wines.

Madeira wine is rich and luscious, and has a pungent, aromatic, nutty or bitter-sweet flavour; and according to Brande and Prout, the true kinds of it contain 22·27 per cent. of alcohol, the West-Indian kinds 21·2 per cent., and the Sercial kinds 20·32 per cent. Since the reduction in the duty of French and Spanish wines, its consumption in this country has very much decreased, being superseded by Sherry. The best Madeira wine is produced on those estates which lie on the south side of the island of that name; and although this wine is naturally of a strong full body, considerable quantities of brandy are always added, in order to enable it to sustain the high temperature to which it is subjected on voyages to India, large quantities being placed on board ships trading to the East and to China

for the purpose of ripening. The process has been tried artificially by placing the wine in a heated atmosphere, or a hothouse; but the effect is not equal to the voyage, probably on account of the ship's motion. Where good samples are selected, and the wine seasoned, it proves of excellent quality, most of the adventitious spirit being evaporated, and it will keep for any length of time, improving by age. Indeed Madeira wine is not considered to have arrived at maturity, until it has been ten years in the wood, and twice that time mellowing in bottle. The quantity of wine made at Madeira has never exceeded 20,000 pipes, and a portion goes to America and the West Indies. Previous to the reduction of duties, about 300,000 gallons were entered for home consumption in England, and adulteration was practised to a greater extent upon this wine than upon Sherry at present. Teneriffe wine resembles Madeira, and, according to Brande, contains 19·79 per cent. of alcohol.

Malmsey wine took its name from Malvasia, a town in the Morea, whence the grape for it was originally obtained, but which does not now produce any good wine, and Malmsey Madeira wine is a luscious, sweet beverage, made from overripe grapes grown in a rocky part of Madeira,—containing only 16·4 per cent. of alcohol,—imported in very small quantities into Britain,—and used principally as a liqueur or at dessert.

Marsala wine is produced in the neighbourhood of Marsala, the ancient Lilybæum, in Sicily. It varies widely in quality; but was greatly elevated in character, and brought to a state of steady excellence, not many years ago, by some English producers who erected an extensive establishment in the district; and in consequence, it came rapidly into great repute, and rose rapidly in the scale of our imports. It closely resembles the lighter sorts of Madeira, and is much cheaper; and though the quantity imported into Britain in 1823 was under 80,000 gallons, the quantity rose against 1840 to about 400,000 gallons. Average specimens of it, according to Brande, contain 25·9 per cent. of alcohol; but a specimen of it, twenty years old, and submitted during five years to Soemmerring's process, contained, according to Prout, only 18·4 per cent.

Cape wines have been considerably improved of late years, and the consumption in England is great, not under this denomination, but for the purpose of mixing with Sherry, Madeira, and other good wines. The Cape of Good Hope being a British possession, the duty on its wine produce, at the time of the reduction, was fixed at 2s. 6d. per gallon, while that on foreign wines was fixed at 5s. 6d.; and hence there soon was an importation of upwards of 500,000 gallons annually of a very inferior wine, which has an earthy disagreeable taste, and a total want of aroma and flavour. There is a wine called Constantia grown at the Cape, upon two farms of that name, near the base of Table Mountain, and this is much esteemed, being very luscious, and little inferior to the muscadine of Languedoc. A specimen of it analyzed by Prout contained 14·5 per cent. of alcohol; and two specimens analyzed by Brande, the one red and the other white, contained respectively 18·92 and 19·75 per cent. Another kind called Steen wine resembles Rhenish, and was found by Prout to contain only 10·6 per cent. of alcohol. The Cape Muscbat is a sweet wine, and contains 18·25 per cent. of alcohol; and the Cape Madeira has a harsh and earthy taste, and contains 20·51 per cent.

Claret wines are produced principally in a district of France called the Bordelais, and in the fertile country on the banks of the Gironde. The most esteemed are the Lafittes, Latours, Chateau-Margaux, and Haut-Brion, these always fetching from 20 to 30 per cent. higher price than any other sorts in the district. Of the four named, the Lafitte is generally preferred, on account of its softness on the palate, bright colour, and exquisite perfume, partaking of the violet and raspberry. The Chateau-Margaux has the same delicate qualities, but not quite so high a flavour, while the Latour has fuller body, and the Haut-Brion is stronger than either, requiring considerable time to mellow in the wood and the bottle before it arrives at perfection. The second-rate clarets are innumerable, and of various qualities, some approaching to the first rates, and usually substituted for them in this country. The adulteration of clarets is great; and unless purchased in bond, or of a wine-merchant of established character, you can never be certain that the article is genuine. Average clarets contain about 15 per cent. of alcohol; good red clarets, such as the Haut-Brion and the Haut-Talanu, contain nearly 13·5 per cent.; and the amber-coloured clarets, such as the Barsac and the Sauterne, contain about 14 per cent. Most of the prime clarets, such as the Lafitte, the Latour, the Chateau-Margaux, the Leoville, and the Rauzan, have a deep purple colour, a delicate flavour, and more or less of a violet perfume; and some other good kinds, such as the Haut-Brion and the Merignac, resemble the better sorts of Burgundy, but are rougher. But some of the red sorts, such as the Canon and the St. Emilion, have a harsh taste and an odour somewhat like that of burning sealing-wax; and many of the best known white sorts, such as the Langon, the Cerons, the Preignac, the Beaumes, and the Buzet, are of inferior quality.

Champagne is the French wine held in most esteem in England, particularly by the ladies; and no beverage is more deserving of its high reputation, provided it be of the right sort. There are two kinds of champagne, the white and the red; and these are again distinguished as the still and the sparkling. Of the still, the Sillery is most esteemed, being of a light amber colour, with a delightful aroma and good body. The Ay is considered the best of the sparkling champagnes,

being the produce of a district a few miles south of Rheims; it is lighter and sweeter than Sillery; and that which creams on the surface, instead of frothing up like cider or perry, is considered the best. These, or imitations of them, are the French wines generally consumed in England. The province of Champagne produces altogether upwards of 1,100,000 hectolitres or about 24,200,000 gallons of wine; but the finest growths form but a small part of this quantity. Champagne is much improved by icing; and many assert that inferior qualities, and even the imitations called British, relish better than the superior sorts when this precaution is neglected in the one case and adopted in the other, particularly in warm sultry weather, when this delicious wine is so grateful to the taste. A specimen of Sillery analysed by Brande contained 13·3 per cent. of alcohol; and a specimen of Verzy, a red champagne, contained 11·93 per cent.

Burgundy wines are regarded by the majority of nice and fastidious judges as preferable to champagne. A sharp controversy on the merits of each took place during the reign of Louis XIV., which appears to have been decided in favour of Burgundy,—a wine, as Henderson remarks, "in richness of flavour and perfume, and all the more delicate qualities of the juice of the grape, unquestionably ranking the first in the world; and it was not without reason that the dukes of Burgundy in former times were designated as the *princes de bons vins*." Chambertin, Romanie-Conti, Clos-Vougeôt, and Richeburg, are the most celebrated of the red wines of Burgundy. The first was the favourite wine of Napoleon, and is produced on a spot of about 65 acres, a little to the south of Dijon, the annual vintage being about 140 puncheons. The white wines of Burgundy are not held in such repute as the red in this country, or by foreigners generally; but in France, they are considered little, if any, inferior in aroma or quality. The entire produce of wine in Burgundy and Beaujolais is about 3,000,000 hectolitres, of which the inhabitants consume 750,000; the rest is marketed at Dijon, Givry, Châlons-sur-Saône, &c. &c., and exported to all parts of the world. The best red wines of Burgundy have a beautiful, rich purple colour, an exquisite flavour, and a full body, and yet are delicate and light; and the best white wines of Burgundy, such as the Mont Rachet, have a high perfume and a nutty flavour. Brande states the proportion of alcohol in Burgundy wines at 14·57 per cent.

The German, Rhenish, or Hock wines, consumed in England, are produced on the banks of the Rhine and the Moselle. They are generally used for dinner, being drier and more aromatic than the French white wines; and the best of them have a peculiar flavour, much relished by good judges, and called by the natives gäre. By some they are considered acid; but this is the case with only the inferior sorts, or when there has been a bad vintage,—for the produce of warm dry seasons is quite free from this defect, and always commands the highest prices. The Johannisberger, grown on the estate of Prince Metternich, is universally admitted to be the best of the Rhine wines, from its choice flavour and perfume, and the absence of the least acidity. The Steinberger ranks next; it is a strong wine, and improves by age. Both these sorts are very rare, the district which produces them being extremely limited. The generality of Hocks consumed in England are grown on the banks of the Moselle, and some are of excellent quality, although they vary prodigiously in that respect. They require keeping for five or six years, in order to mellow. A specimen of old Johannisberger, analysed by Prout, contained only 8·71 per cent. of alcohol; specimens of Rüdesheimer and Grafenberg contained 10·72 per cent.; a specimen of Bodenheimar, a red Rhenish wine, analyzed by Zez, contained 13·96 per cent.; and average specimens of Hocheimer, or real red Hock, are stated by Brande to contain 13·68 per cent.

Bucellas, a Portuguese wine of pale colour and delicate flavour, contains 18·49 per cent. of alcohol; Carcavellos, a Portuguese wine of amber colour and sweet taste, contains 18·65 per cent.; and Vinho de Ramo and Collares, two Portuguese wines of deep purple colour, and rough, bittersweet, spirituous taste, contain respectively 15·62 and 19·75 per cent. Malaga, a Spanish white wine, contains 18·94 per cent.; and Tent or Tintilla, a Spanish wine of purple colour, sweet taste, and strong spicy flavour, contains 13·3 per cent.

Syracuse wine, a Sicilian production both red and white, contains 15·28 per cent.; Lissa wine, a Sicilian production resembling claret, contains 15·9 per cent.; and Etna wine, a Sicilian production, similar to Madeira but possessing the harsh flavour of Sicilian brandy, is the most spirituous of all the wines of commerce except red Hermitage, and contains so much as 30 per cent. Montepulciano, a sweet-tasted, high-flavoured wine of Italy, contains 22 per cent.; Aleatico, an Italian wine of brilliant purple colour, luscious taste, and aromatic flavour, contains 16·2 per cent.; and Lacrima Christi, a red, sweet, luscious Italian wine, contains 19·7 per cent. Among other Italian wines may be mentioned Verdea, of a greenish colour and high flavour; Albana, of a pale straw colour and light character; Trebbiano, of a golden colour and sweet taste; Orvietto, both red and white, and of light character; and Monte Somma and Gallite, fine varieties of Lacrima Christi.

Red Hermitage wine is a French production; and, in all its fine varieties, such as Beaume, Greffieux, Raucoule, Basas, and Meal, it has a dark purple colour, an exquisite flavour, and a somewhat similar odour to raspberry, and contains about 32·2 per cent. of alcohol. White Hermitage or Vin de paille has an amber colour and a sweet luscious taste, and contains 17·43 per cent. of al-

cohol. Cote Rotie or Verinay resembles white Hermitage in colour and flavour, but does not contain quite 13 per cent. of alcohol. Frontignac has a light colour, a luscious taste, and a grape flavour, and contains 12·79 per cent. of alcohol. Lunel or Clos-Mazet has a bright yellow colour, and is less luscious than Frontignac, and contains 15·52 per cent. of alcohol. Red Rousillon, in all its principal varieties, has great body and colour, and becomes tawny when old, and contains 18·13 per cent. of alcohol. Among other French wines may be mentioned white Rousillon, of a bright golden colour, a fragrant aroma, and a quince flavour; Clarette of Die, of light colour and character, sparkling, and delicate; Seyssuel, of a light colour and violet perfume; Cornas, of full rich red colour, and of the flavour of ratafia; Vin de Cotillon, of violet colour and sprightly character: and Tavel, Chuzlan, and Beaucaire, of bright rose colour, and of delicate flavour and aroma.

The far-famed Tokay wine is produced near the town of Tokay in Hungary; but is now scarce and dear in Britain, very seldom used, and difficult to be got genuine at any price. It is much more fit for a cordial than for a beverage. It is rich, luscious, and of exquisite aroma; and has a brownish-yellow colour when new, and a greenish colour when old; and contains only 9·88 per cent. of alcohol. A kind called Tokay Essence is syrupy, thick, and muddy. Another Hungarian wine, called Menser, resembles Tokay and is sweet; and a fourth kind, called Ansbruck, is thinner and more vinous.

The Vino Santo of Cyprus has a pale straw colour and a sweet taste. The Rithymo or wine of Candia is a fine flavoured white wine. The red wine of Ithaca has a flavour similar to Hermitage. The wine of Tenos is sweet and luscious. The white Muscadine of Smyrna is also sweet and luscious; and the red Muscadine of Tenedos resembles Tokay. The modern wines of Greece and the Levant, in general, are comparatively poor; though the ancient wines of these regions were rich and diversified,—and though, so late as the times of the Venetian Republic, Cyprus and Candia alone supplied all Europe with the choicest dessert wines.

The grape wine of England resembles Rhenish, and contains, according to Brande, 18·11 per cent. of alcohol. Our raisin wine is diversified, and contains, on the average, about 25·12 per cent. Our currant wine is still more diversified, and contains about 20·5 per cent. Our gooseberry wine has a briskness similar to that of Champagne, and contains 11·84 per cent. Our elder wine is thick and narcotic, and contains 9·87 per cent. Our orange wine is sweet and luscious, and has a flavour similar to that of raw oranges, and contains 11·26 per cent. And our apple and pear wines are simply cider and perry, and contain respectively 9·87 and 7·26 per cent.

The Dietetical and Medicinal Uses of Wine.—"Wine when good, and of a proper age," says Dr. Anthony Todd Thomson, "is cordial and tonic; but when new, it is flatulent, debilitating, and purgative, and intoxicates sooner than old wine. In a dietetical point of view, the temperate use of wine promotes digestion, and gives additional energy to the action of the heart and arteries, strengthens the animal functions, exhilarates the spirits, sharpens the wit, and calls into action all the intellectual powers. But when taken in excess, it intoxicates, producing sickness, headach, vertigo, and diarrhœa, with nervous tremors, which continue for two or three days; and, like ardent spirit, its habitual excessive use extinguishes the faculties of both body and mind, producing dyspepsia, emaciation, and debility, hepatic and pulmonary inflammation, palsy, gout, dropsy, delirium, tremors, and a long train of diseases and wretchedness. We nevertheless hear of very extraordinary quantities of wine being drunk with impunity by some individuals. I knew a man who had not retired sober to bed for twenty years; and yet lived to upwards of eighty years of age. Drunkenness, however, is the vice of barbarians; and, as nations merge from that state, it evidently becomes less prevalent. In Britain it is now happily confined to the dregs of the people. As a remedy, wine is stimulant, antiseptic, tonic, and anti-spasmodic. Its stimulating properties are less diffusible, but more permanent, than alcohol; and thence its dose is more easily regulated, and its effects are more certain. In all diseases accompanied with much debility, as typhoid fevers, and in cases of extensive ulceration or gangrene, wine is not only the best addition to cinchona bark and opium, but is a remedy on which alone there is much reliance; in some convulsive affections, as symptomatic tetanus, and chorea, much benefit has been derived from its use; and in the convalescences from all severe diseases, it is the most efficacious and the quickest mean we can employ for restoring the exhausted strength and vigour. Wine operates less powerfully on the system in a state of disease than in health; the quantity, however, to be given, and the proper period of exhibiting it, require to be regulated with much judgment. The skin being open, and not dry or hot, the strength sinking, and the ulcerations, if any exist, assuming a gangrenous appearance, indicate the use of wine; and when, in the event of the pulse being low and fluttering, wine restores its firmness without increasing delirium, and induces sleep, it may be given with a confidence of the greatest benefit. But if, on the contrary, it renders the pulse quicker, increases heat, thirst, delirium, or watchfulness, its exhibition ought immediately to be discontinued. The quantity to be given depends entirely on the nature of the disease, and the intentions for which it is administered. In typhus, the proper rule is to give it till the pulse fills, the delirium abates, and the extremities warm; and it should be re-

peated on the smallest appearance of stupor, quick and sinking pulse, or tremor. A few glasses, and these even diluted with water, given in the space of twenty-four hours, will often produce all that is required from wine; but sometimes very large quantities are necessary. In a case of symptomatic tetanus, mentioned by Currie, five bottles of Madeira wine were taken every day for some time, without producing the least symptoms of inebriety, or morbidly exciting the pulse; but, on the contrary, with the utmost advantage in allaying irritation, and relieving the patient. In ordinary cases of fevers, however, wine is, perhaps, in general, too freely given, so as to occasion exhaustion instead of supporting strength. In a dietetical point of view, wine is useful or prejudicial, in proportion as the fermentation is more or less perfect. In wines containing the malic acid, when the fermentation has been imperfect, the fermentative state of the liquor is recommenced in the stomach, and much carbonic acid and other gases are evolved, which, distending that organ, oppress the individual; and if he be dyspeptic, produce depression of spirits and all the horrors of hypochondriacism. When wine, however, is good, it stimulates gratefully the nerves of the stomach, and, consequently, promoting a more healthy secretion of the gastric fluid, greatly assists the chymification of the food. *Sweet wines* are more apt to become acescent than the dry wines; but it is erroneously conjectured that the same objection applies to the use of the *Rhenish wines;* for, as these wines contain much free tartaric acid, and scarcely any malic or gallic acids, they are less liable to ferment than many of the stronger wines. Sparkling, brisk wines, such as Champagne, intoxicate more speedily than the stiller wines, but the morbid excitement is of short duration, and the subsequent exhaustion is comparatively trifling. They are said to induce gout in those strongly predisposed to that disease; but, probably, more is to be attributed to the luxurious dishes which generally accompany the use of Champagne, than to that exhilarating beverage. In febrile habits, Burgundy, Port, and the stronger white wines, are to be avoided; but in diseases of debility, particularly where the stomach requires the aid of a tonic, these wines will prove beneficial. In convalescence, however, from acute diseases, if wine be admissible, claret or some of the better kinds of Rhine wines—for example, Moselle or Hock—are preferable; and this is particularly the case, if with a low pulse and much exhaustion the nerves are so excitable as to produce a febrile action in the arterial system, on the application of stimulants, either corporeal or mental. In those who have a disposition to obesity, the Rhine wines, on account of their diuretic properties, are preferable to every other kind for daily use. Where health abounds, wine is altogether unnecessary; but, as habit has rendered the use of it general, it is to be lamented that, in this country, the high prices of the more wholesome kinds force the great majority of the middling ranks to indulge in the use of those which contain too large a quantity of alcohol, and the lower classes to the abuse of spirituous liquors. When wine is prescribed as a cordial in a state of convalescence from acute diseases, or in a weakened state of the habit, it should not be taken with dinner or any other meal, but at noon, upon an empty stomach."

WINE-PALM,—botanically *Manicaria saccifera.* An Indian palm-tree, of commonly about 30 feet in height. It constitutes a genus of itself; and was introduced about 26 years ago to the palm-houses of Britain. See the article PALM.

WINE (SPIRIT OF). See ALCOHOL.

WING. The wings of birds correspond to the fore legs of quadrupeds and the arms of man. The clavicle of birds is a hollow tube of great strength, and the fork is peculiar to winged animals. The different bones of the wing are bound together, and connected with the bones of the body, by strong ligaments; and the muscles by which motion is communicated to them are the most powerful with which the animal is provided. All this peculiar apparatus is necessary to give due force to these instruments of locomotion. The construction and disposition of the feathers are not less curious, and admirably adapted for the purpose of flying. The best form of windmill sails, which human ingenuity and science have been able to devise, bears a striking resemblance to the arrangement of the feathers in the wings of birds, and is one of many beautiful instances of the mathematical exactness of the principles on which the works of creation are constructed. The form of the wings is most accurately adapted to the habits of the birds. There are two forms, which have received the names of the *rudder-formed* and the *sail-formed* wings: the former are long, slim, and tapering, as in the falcons, swallows, &c.; the latter broad, long, and rounded at the end, as in the swan, goose, &c. The former are for quick, sudden, and rapid motion, and are moved often; the latter for floating a long time more slowly through the air.—The wings of insects are membranous, elastic, for the most part transparent, and traversed by firm air-vessels, which sometimes form a beautiful net-work. In some they are naked; in others, as in the butterflies, they are covered with fine, soft, feathery scales: in some they are extended and straight, in others folded. Some insects have four wings, and others but two; the latter are commonly provided with poisers or balancers (*halteres*). The difference in the structure and disposition of the wings is one of the distinctive marks on which the division of insects into orders is founded: thus we have the *hemiptera*, the *coleoptera*, the *lepidoptera*, the *neuroptera*, &c.—Quadrupeds which fly are provided with membranes extending over the bones of the extremities, by which they are enabled to

impel themselves through the air; others merely have the skin so loose on the sides as to be spread out when the limbs are extended, and, being buoyed up in this manner, they are able to make surprising leaps.

WINNOWING. The cleaning of thrashed grain from chaff and dust. In rude states of society, this is done simply by exposing the grain to the currents of the atmosphere, either superficially or by tossing according to the strength of the wind; but in better states of society, even from remote times, it has always been done with more or less of implemental aid,—and in the improved husbandry of Britain and other highly civilized countries of the present day, it is done by means of special machinery, either attached to the thrashing machinery as in the case of the Scottish thrashing-mill, or used separately as in the case both of small Scottish farms and of all the English farms which use travelling or ordinary English thrashing-machines. See the articles Barn-Management, Thrashing-Machine, and Winnowing-Machine.

WINNOWING-MACHINE. Implements similar to modern shovels, but differing from one another in different ages and in different countries, were used by ancient Orientals, Greeks, and Romans for tossing thrashed corn upon their out-of-door thrashing-floors so as fully to expose it to gently-blowing winds; for if corn, in the open air, is thrown several times across the wind, and well scattered in throwing, the chaff, being light, not only falls short, but also is blown away. Two other implements seem also to have early come into general use,—the one of the nature of a large fan for wafting off the chaff when no sufficient natural wind was blowing, and the other similar to a modern sieve for freeing the grain from adherent and intermixed earth and dust. "The oxen likewise and the young asses that ear the ground," says the prophet Isaiah, "shall eat clean provender, which hath been winnowed with the shovel and with the fan." "I will command, and I will sift the house of Israel among all nations," says the Most High by the prophet Amos, "like as corn is sifted in a sieve, yet shall not the least grain fall upon the earth." The fan also is alluded to in a passage of the New Testament which metaphorically describes the ministry of the Redeemer; and the sieve in another which foretold the terrible trial of the apostle Peter's faith at the time when the Redeemer was betrayed; and both, as well as two winnowing kinds of shovel, are mentioned in numerous extant passages of Greek and Roman authors. "When the corn is mixed with the chaff," says Columella, "this ought to be separated in the wind. The west wind is reckoned the best for this purpose, because it blows soft and equal during the summer months. Yet, to wait for this wind is the sign of a slothful husbandman; for, while he is expecting it, he may be overtaken by a severe storm. In the thrashing-floor, therefore, the corn that is thrashed should be so heaped up, that it may be cleaned with any wind. But if for several days the weather should continue quite calm, the corn must be cleaned with fans; lest, after a calm, a severe tempest should destroy the labours of the whole year." The fan, conjointly with the shovel, continued in use throughout all the middle ages, and has even been perpetuated, in the least improved districts, to the present day. An esteemed form of it in comparatively late times consisted of four pieces of wood, placed longitudinally in the direction of an axis, each having fastened upon it a piece of cloth or canvas; and this was made to revolve by means of a handle or winch, so as to produce a steady and somewhat strong current of air,—and the corn was tossed into the current, or scattered across it, with the shovel.

The first fanning apparatus, turned by machinery for driving off chaff and dust, was invented by the Chinese, and applied to the cleaning of rice. It was thence introduced to Holland, and attached to mills for making pot or pearl barley; and, in the early part of last century, it was introduced from Holland to Scotland, through the patriotism of Andrew Fletcher of Salton, and the ingenuity of James Meikle, father of the inventor of the thrashing-mill. A large and improved form of it, applicable to all sorts of grain, yet requiring the corn to be twice or thrice passed through it before complete cleaning could be effected, began to be manufactured about the year 1733 by Rogers of Cavers in Roxburghshire. Another form, also of general applicability, and probably somewhat better than Rogers', yet likewise requiring the corn to be twice or thrice passed through it, was patented in 1768, by A. and R. Meikle. An improvement, "so combining the properties of various machines, that the grain at one operation could be both separated from the chaff and lighter seeds and completely riddled of all sorts of refuse," was afterwards made by Moodie of Lilliesleaf. A highly improved machine—which continues in use and is eminently approved to the present day, and which obtained a prize from the Royal Agricultural Society of England so recently as the year 1841—was patented in 1800 by Mr. Cooch of Northampton. "This machine," says Mr. Ransome, "dresses all kinds of seeds; and its work is performed in a perfect manner. Its principle involved more mechanical combinations than were at that time generally understood by the class for whose use it was intended; and this, together with its then cost, long retarded its more general adoption." Another eminently efficient implement, quite as useful as Cooch's, but simpler in the arrangement of its parts, easy to be worked, and apt to keep long and steadily in order, was patented in 1812 by John Elmey; and this, under various modifications adapting it to hand-work or to the thrash-

ing-machine, or introduced by the taste of different manufacturers or the ingenuity of different improvers, is now par excellence the winnowing-machine of almost all Scotland, and of a large part of England. A full and minute description of one of the best ordinary varieties of Elmey's machine, therefore, will substantially serve as a very satisfactory account of the whole of this class of implements; and such a description, ably and technically written, together with illustrative diagrams, lies happily at our hand in the 3d Volume of the Quarterly Journal of Agriculture.

"AB and CD, *Fig.* 1, are two standards of ash 3 inches square, and 4 feet long, with their fellows on the opposite side. These standards are fastened together longitudinally by a rail, one at each side, as seen at EF, also of ash, 3 inches square, and 3 feet 11 inches long, inserted into GB and CD, 3 feet 2 inches from B and D; and transversely they are connected by ash-rails 1 foot 9 inches long, and 3 inches by 2 in breadth, at C, I, G, H and B: thus a frame of ash is formed upon which the rest of the implement is constructed. This frame is lined inside of the standards, on both sides with thin fir deal, from C as far down as D; from A 11 inches below F to H; 1 foot 2 inches from A to *t*; and 6 inches from H to *q*. The large cast-metal wheel L, 2 feet 4 inches in diameter besides the teeth, is divided into 6 segments, either of which are removable by screws for the purpose of repair; it contains 144 teeth, and is fixed to an iron axle, both ends of which rest on brass lockers 6 inches long, on the rail EF, and its fellow. The shank of the handle M is 9½ inches in the straight line; and the handle, a hollow cylinder of wood moveable round an iron spindle fastened at right angles to the shank, is 9 inches long. The shank screws on to the axle in the line of motion, as from M to E. The pinion N, also of cast-metal, 6 inches in diameter besides the teeth, contains 28 teeth; is fastened on the end of the axle of the fans O;

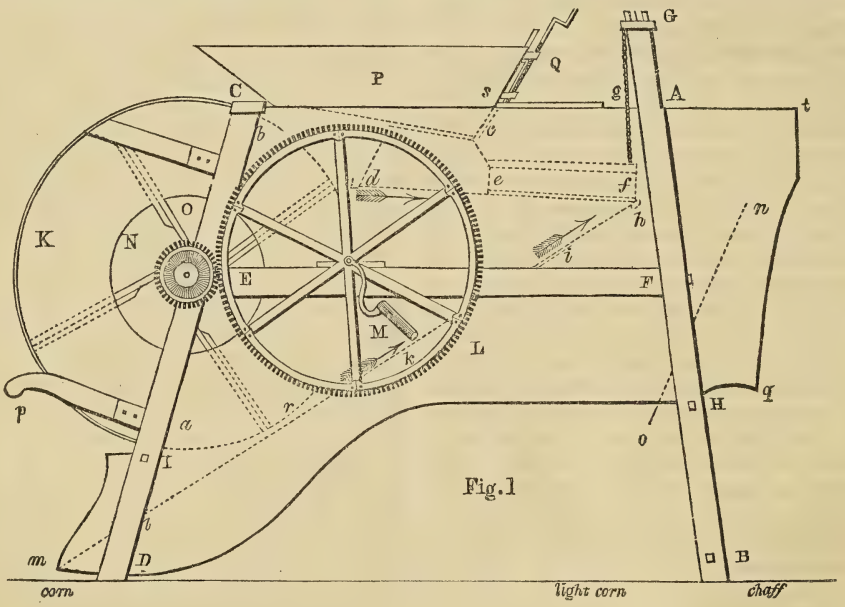


Fig. 1

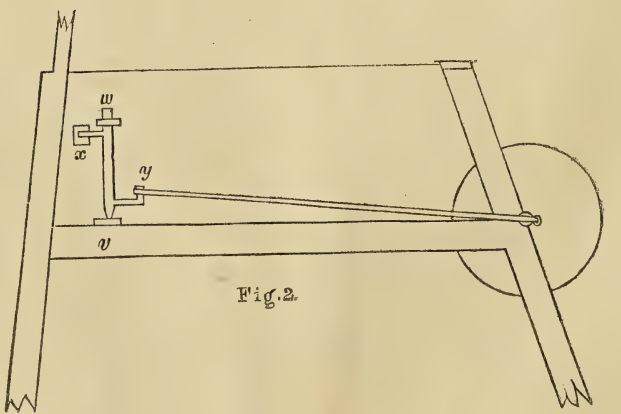


Fig. 2.

and is acted on by the large wheel L. The fans O are four in number, and stretch 2 feet 8 inches in diameter. They are each fastened on, parallel to a face of the square block of wood, which moves round with the axle of the pinion N. The coom, as it is termed, K, which embraces and closes in the fans, is 2 feet 9½ inches in diameter, and 1 foot 10 inches in breadth; and can be removed at pleasure, for the purpose of repairing the fans, by unscrewing the nuts at *a* and *b*. The circular space N, O, E, through which the supply of the air to the fans is furnished, is 1 foot 4 inches in diameter. The hopper P rests from C to *s*, 2 feet along the top of the machine, and is at the extremity of the projection at C 6 inches, and at Q 7 inches above it, measured perpendicularly. The top of the hopper spreads out in length 2 feet 6 inches, and in breadth 2 feet 4½ inches. Its bottom descends 4 inches to *c* below the line of C *s*, and at *c* has a semielliptical hole cut out across its whole breadth. There is also a rectangular hole of about 4 inches high cut out of its front, over which the slide *s* passes up and down by means of the screw Q, which regulates the quantity of grain emitted from the hopper in the process of cleaning. The top of the apparatus *d e f* fits under the bottom of the hopper, and forms its shoe, which, by operating on the grain through the elliptical hole made there, puts it in motion. This apparatus is suspended by an iron pivot at *d*, which is placed in a rail fastened across the breadth of the machine there; and its other end is supported by two chains 1 foot ½ inch long each, hanging from the cross rail G, which connects the top of the standard AB and its fellow; and which are both produced 8 inches above the top of the machine, in order that these chains may have more liberty to oscillate. The frame *e f*, 1 foot 3 inches long and 4½ inches deep, is fastened together transversely by iron rods 1 foot 4 inches in length rivetted at both ends. Into the part corresponding with the dotted line immediately above the letters *e* and *f*, are slid the riddles which are used for the sifting of the different kinds of grain. These riddles, made of iron-wire, fastened to a narrow frame of thin iron, are 1 foot 3 inches in length, and nearly 1 foot 4 inches in breadth. That for wheat contains 4 squares in the length of an inch; for barley, 3 squares; for oats 2¾ squares; and that for roughs, as the roughest uncleaned grain is termed, a square of 1½ inch to the side. The riddle is moved by a small iron rod *u y*, *Fig.* 2, 3 feet 8 inches in length, fastened at one end, which is eyed, by a nut which screws into a crank, fastened on the end of the fan axle opposite to that of the pinion N. This crank must not exceed 2 inches in play. The other end of the rod, which is also eyed, is fastened by a nut to the under arm *y* of the crank *w v*. A piece of leather, placed on each side of the eyes of the rod, softens the noise of the machine very much. The other arm *x* is fastened by two intermediate joints to a jointed staple in the frame *e f*, through a hole in the lining of the machine. These arms are 2½ inches long, and set at right angles to each other, and also at right angles to the shank of the crank *w v*, which is 9½ inches long, and which at *v* performs a quadrantal motion in a socket, and at *w* through the staple. The grain falls upon the inclined plane *h m*, the upper part of which, *h i*, 1 foot long, is made of sheet iron, and slides up and down at pleasure. From *i* to *m* is of deal nailed firmly, with the exception of the part from *k* to *l*, which forms a screen of wire-gauze 8 squares to an inch in length, stretched on a frame of wood, and nailed with tacks through a selvage of tin. This screen permits all the dry earth, sand, or seeds of wild plants which may have been in the grain to pass through. *n o* is a board 2 feet long, which moves up and down at pleasure, and is kept in its place by a wooden catch on the cross bar at H. The chaff is blown over the top of this board at *n*, and falls down beyond B. The light corn falls over *h*, and down below *o*, while the clean grain slides down *h m* to *m*. The space between the standard AB and its opposite fellow, is lined up with deal, 2 feet 3 inches, as far up as H, to keep the chaff and light corn separate. The top of the machine is covered in front of the hopper P, as far as to *g*, 1 foot 1 inch. The coom is continued as far round as from *b* to *d* above, and I to *r* below, the current of air passing up in the direction of the arrows at *k* and *i*, *p* and *q* form two handles, by which two females can lift the whole machine anywhere with great ease. To save the inside of the lining where the frame *e f* beats against it, it is necessary to place a stout piece of plate iron around the point of contact on each side; and it must be fastened with screw nails, as the constant beating will soon start common nails. It is recommended not to use any oil, because the dust of the barn soon forms a paste with it, which will clog the motion of the machine. The gudgeons should rather be turned smooth on a lathe at first. The peculiarities which are apparent in the construction of the machine described above, consist in placing the standards at an angle to each other, the distance between A and C being only 3 feet 4 inches, whereas the distance between B and D is increased to 5 feet 2 inches, and which is produced 4 inches more to *m;* by this arrangement, the part *m*, at which the clean grain issues out, is placed more prominently, and of course more conveniently, for the person who takes away the grain to be riddled. This arrangement, too, obviously increases considerably the length of the inclined plane *h m*, and of the wire-gauze screen *k l*, over both of which the grain slides in its descent to *m*, and through the latter of which it deposits any sand, earth, or small seeds of wild plants which are mixed with it, and even any shrivelled light corn that may have escaped the force of the wind. It also lowers the angle of the inclined plane to 32° instead of 45°, by which

the grain, in descending, gets more time to deposit its impurities. The coom K is by this arrangement placed a little more out of the way of the person's head, who takes away the grain. The large wheel L is also an improvement. The pinion N, upon which it operates, makes fully five revolutions for one of the large wheel; and as in ordinary cases the latter only requires to make twenty-eight revolutions in a minute, the fans O will therefore make 144 in the same time. This easy motion to the driver of the wheel, for which a woman has sufficient strength, thus generates an immense current of air by the rapid motion of the fans. This current, though amply filling the place from *d* to *r*, 2 feet, is forced in the direction of the arrows, through the riddle, and of course between the grains of corn which are at the same time passing through it, and makes its escape by an aperture of only 10 inches from *f* to *g*, the width of the machine between the linings being only 1 foot 8 inches. To facilitate still farther the driving of the machine, it is necessary to make the shank of the handle M 9½ inches long, and which, as a radius, will be found to describe a circle round the axle of the wheel, the most convenient in size for the easy motion of the body of the driver. The slide *s* should only be elevated above the bottom of the hopper 1 inch, and in order to make the emission of the grain from it more complete, the hopper should always be amply supplied with corn. Many contrivances have been adopted by introducing pinions and shafts and rollers, pitch wheels and pitch chains, and sheaves and belts, to shake the riddle, and supply the corn regularly to it from the hopper, in order to supersede the use of the old spear and crank and shoe, as described above. These contrivances have no doubt to a certain degree succeeded. But none of them can supply the grain *more* regularly, or imitate the vibratory motion of the human hand in riddling *so well*, as the combined motion arising from the simultaneous action of the loose spear and crank, the quick oscillations of the long chains *g*, the sort of undulating vermicular motion of the shoe *d* at the pivot, and the five gentle beats of the riddle frame *e f* against the lining of the machine, to one turn of the large wheel; while any set of these other contrivances imposes a considerable additional weight for the driver to overcome."

The machine, when attached to the thrashing-mill, is made comparatively heavy; and, when used separately, is made so light as to be easily removeable from one part of the barn to another. In different forms of it, a single sieve may be made to do all or nearly all the work of the two sieves,—the heavy corn may be made to fall out either at the end or through a spout at the side,—the light corn may be discharged either below the machine or through a spout,—and the part of the inclined plane through which the dust and sand fall may either be a fixture so as to act as a mere screen or steady riddle, or be oscillatingly moveable so as to act as a shaking sieve. An improvement of the machine, by Mr. Docker of Findon in Banffshire, for better adapting it to conjoint working with the thrashing-mill, assumes that it is commonly too narrow for due efficiency in connexion with very powerful mills, and that it cannot be made broad enough in its ordinary construction without suffering disproportion between the strength of its blast and the increased width of its fan; and it provides for this defect by adopting a double-headed fanner or a conjunction of two comparatively narrow fans, and by admitting the air between the heads as well as on the outsides, so that the two blasts become combined on leaving the fans. Another improvement or variety, invented by Mr. Common of Denwick, has bands instead of wheels. A light supplementary implement, called a fan or a blowing machine, is used in some barns for dusting and cleaning grain which has not come clean enough out of the winnowing process, or which has acquired dust and impurities from exposure; and this is quite simple in construction, and has a straight vent for the blast, and has not any riddling or sifting apparatus. See the article THRASHING-MACHINE.

Parsons and Clyburn's patent winnowing machine, manufactured at the Earl of Ducie's Iron Works in Gloucestershire, differs widely from all other winnowing machines. "The fan or blower," say the makers of it, "is about 3 feet in diameter at its greatest radii, and 2 feet 6 inches at the smallest. The fans are placed at an angle of 45°, so that when put in motion, the wind enters at the smallest side and is driven out at the largest, filling a space or chamber 3 feet square, with wind. The riddle is placed in the middle of the chamber, with a vibrating motion. As the grain with the chaff in it drops from the feed-roller to the riddle, it meets with the wind from the upper side of the fan, which blows out the chaff before it gets into the riddle; the grain after passing through the riddle, is concentrated in the small hopper; when it leaves the hopper, it meets with the wind from the lower side of the fan, which drives the light grain farthest from it into a spout provided for that purpose, leaving the best and heaviest to fall down into another spout nearer to the wind, thus completely separating the light from the heavy grain. One of the great improvements in this machine, is making the fan of such a form that it will give a greater degree of wind for the grain to fall through, than in the other machines; another is, its having one of Hornsby's registered feeding apparatus attached to it."

Salter's winnowing machine, invented by T. F. Salter, and patented in 1839, combines the apparatus for winnowing and dressing grain with the principles of a barley hummeller. "The undressed grain from the hopper," says Mr. Ransome, in his Implements of Agriculture, "passes

through a cylindrical sieve, having within it a rotatory spindle, upon which short blunt arms are arranged in a spiral direction; these agitate the grain as it passes along, and thus separate the small dirt and dust as well as the awns of barley, which fall through in a closed box or cupboard. The cylinder is placed in a slanting direction, and is provided at each end with slides, which regulate the quantity and speed with which the grain shall pass. Through the slide aperture at the lower end, the grain is introduced upon other sieves, which, having a backward and forward motion, distribute it equally over their surface while it is subjected to the blast of the fan, driving obliquely through the sieves; this carries the chaff out of the machine; the grain falls on a screen, which, having a similar motion to the sieves, separates from it all small seeds, and the dross corn is carried away in a division formed for the purpose. The grain, dross corn, and chaff are thus all thoroughly separated from each other; and the dust, dirt, and small seeds, having fallen in an enclosed box from the cylinder, may be entirely removed. I have heard this machine highly approved by many,—and when pains are taken to separate the corn from the short straw, &c., previously to submitting it to the machine, I believe it to be very effective; but as there is some degree of complication in its details, it is chiefly suitable to those to whom a high degree of excellence in the manner of 'making up their corn' is a matter of more importance than the time or labour it may require."

WINTER. The season which intervenes between autumn and spring. It is the season of repose to vegetables, and of torpidity to hybernating animals,—of invigoration to soils, and of the digestive preparation of the food of plants,—of frost and snow and storm and tempest,—of the busiest labours of the farmery, and the roughest toils of the farm-field,—of the lowest activity of brutes and the most slovenly existence of fools and libertines,—but of the strongest outgoings of human friendships, and of the loftiest soarings of enlightened intellect. We have sufficiently indicated its natural phenomena and its rural occupations in the article CALENDAR, and have given a large notice of its biological characteristics in the article HYBERNATION; and we may here, in the words of Mudie, very briefly suggest its great moral lessons to reflecting men,—and most of all to men residing in the country. "Winter is the season of Nature's annual repose,—the time when the working structures are reduced to the minimum of their extent, and the energies of growth and life to the minimum of their activity, and when the phenomena of nature are fewer, and address themselves less pleasingly to our senses, than they do in any other of the three seasons. There is hope in the bud of spring, pleasure in the bloom of summer, and enjoyment in the fruit of autumn; but, if we make our senses our chief resource, there is something both blank and gloomy in the aspect of winter. And if we were of and for this world alone, there is no doubt that this would be the correct view of the winter, as compared with the other seasons; and the partial death of the year would point as a most mournful index to the death and final close of our existence. But we are beings otherwise destined and endowed,—the world is to us only what the lodge is to the wayfaring man; and while we enjoy its rest, our thoughts can be directed back to the past part of our journey, and our hopes forward to its end, when we shall reach our proper home, and dwell there securely and for ever. The winter is, therefore, the especial season of man,—our own season, by way of eminence; and men who have no winter in the year of the region in which they are placed, never of themselves display those traits of mental development which are the true characteristics of rational men, as contrasted with the irrational part of the living creation. It is true there must be the contrast of a summer, in order to give the winter its proper effect; but still, the winter is the intellectual season of the year—the season during which the intellectual and immortal spirit in man enables him most triumphantly to display his superiority over 'the beasts that perish.'"

WINTERA. See DRIMYS.

WINTER ACONITE,—botanically *Eranthis*. A small genus of ornamental, tuberous-rooted, small plants, of the ranunculus family. The common winter aconite, *Eranthis hyemalis*, called by Linnæus *Helleborus hyemalis*, was introduced to Britain from Italy toward the close of the 16th century; and has long been almost universally cultivated as one of the earliest and most common winter beauties of the flower border. Its flower is yellow, and sits upon the leaf at the height of two inches or so from the ground, and blooms from January till March; and though neither delicate nor brilliant nor conspicuous enough to compare for a moment with any of the chief floral ornaments of summer, it has abundance of beauty to charm the eye amid the rigours of winter and early spring, and constitutes a delightful companion to the snow-drop. The roots send out numerous offsets, and may be taken up and transplanted after the leaves decay, or between the beginning of June and the latter part of October; but as they are small, and of similar colour to common garden soils, they must be carefully searched for, else many will be left in the ground; and as the plants are only one-flowered, and do not make a good appearance when thin or scattered, the roots should be planted pretty close to one another and in small clusters. The Siberian winter aconite, *Eranthis sibericus*, is similar to the common species, but does not bloom till a considerably later period in the spring, and was not introduced to Britain till 1826. Both species thrive in any common garden soil.

WINTER'S BARK. See DRIMYS.

WINTER BERRY,—botanically *Prinos*. A genus of white-flowered, ornamental shrubs, of the buckthorn tribe. One tropical evergreen species, and ten hardy species—four of them evergreen and the other six deciduous—have been introduced to Britain from America; they vary in height from 18 inches to 6 or 7 feet; and all love a light soil and are propagated by layering.

The whorled winter-berry, *Prinos verticillatus*, is a native of Virginia, Pennsylvania, and other parts of the United States, and was introduced to Britain in 1736. It is one of the tallest species, and deciduous. Its branches are numerous, and feather it down to the ground, and are covered with a brownish-coloured bark; its leaves are alternate, and stand on slender footstalks, and are lanceolate, serrated lengthwise, pretty large, and of a strong green colour; its flowers come out in ones and twos at the joints of the branches, and appear in July and August, but make no show; and its fruit are purple-coloured berries, and remain on the trees throughout the winter, and have a fine appearance. When this plant is raised from seeds, they must be sown in beds of fine sandy earth soon after they are ripe; and as few will come up till the second spring, the beds must be kept in a clean and dressed state throughout the intervening summer; and the plantlets must remain in the beds till the second March after they appear above the ground, and must then be transplanted at very small distances into a nursery plot, and kept there till fit for their final situation.

The smooth winter-berry, *Prinos glaber*, is a native of Canada, and was introdueed to Britain in 1759. It is an evergreen, and somewhat resembles an alaternus. Its branches are numerous, and come out from the lowest as well as highest parts of the stem, and give the plant a very bushy habit; its leaves are alternate, oblong-lanceolate, acute, serrated, and of a strong green colour; its flowers come out in twos and threes on a footstalk from the wings of the leaves, and bloom in July and August; and its berries have a red or purple colour, and continue throughout the winter. The raising of this species from seed is more operose than even that of the preceding; for it requires all the same care, with the addition that each plantlet needs to be set in a pot and kept for a series of winters under special shelter, and finally put down in a protected situation.

WINTER CHERRY. See CHERRY (WINTER).

WINTER-CHICKWEED. See WINTER-GREEN.

WINTER-CRESS,—botanically *Barbarea*. A genus of yellow-flowered, evergreen herbaceous plants, of the cruciferous order.—The common winter-cress, or bitter winter-cress, or yellow rocket, *Barbarea vulgaris*, called by Linnæus *Erysimum barbarea*, grows wild among rubbish, and on waste grounds, and about hedges, in many parts of Britain; and it has some claim, though but a slight one, to a place in the kitchen garden as a salad plant. Its root is tapering and rather woody; its stem is strong, angular, furrowed, leafy, either simple or branched, and from 15 to 24 inches high; its lower leaves are lyrate, with a roundish terminal lobe; its upper leaves are obovate, dentated, strongly ribbed, quite smooth, and of a fine texture; its flowers grow in round-headed corymbose clusters, and have a bright yellow colour, and bloom from May till August; and its pods are quadrangular and about an inch in length. The herbage is nauseously bitter and somewhat mucilaginous. A variety with a profusion of exceedingly double flowers, which bloom in long succession, and pass from yellow to dirty white as they turn old, is common in flower gardens.—The early winter-cress, or Belleisle cress, *Barbarea præcox*, called by Linnæus *Erysimum præcox*, grows wild on the banks of brooks and ditches, and on watery grassy spots, in various parts of England. Its root is biennial or in only the lowest sense perennial; its stem or stems are erect, smooth, somewhat branched, of a violet hue at the bottom, and commonly from 10 to 20 inches high; its lower leaves are lyrate; its upper leaves are deeply pinnatifid, and have linear, oblong, entire segments; its flowers are fewer, smaller, and paler than those of the common species, and bloom from April till October; and its pods are thrice as long as those of the common species, smooth, and exactly square. This species has a better claim than the common one to a place in the kitchen garden, and may be eaten in the same manner as water-cress; and very much resembles that plant in flavour, but is rather more pungent.—Three hardy exotic species have been introduced from Tauria, Iberia, and the Levant; but they possess little interest.

WINTER-GREEN,—botanically *Trientalis*. A small genus of hardy, curious, perennial-rooted, annual-stemmed, white-flowered, herbaceous plants, of the primrose family. The European species, or the winter-chickweed, *Trientalis europæa*, is an indigen of the moist woods, mountain pastures, and turfy heaths of Britain. Its root is slightly tuberous; its stem is solitary, erect, somewhat cylindrical, almost naked except at the top, and commonly from 3 to 8 inches high; its leaves are smooth, and form a tuft at the top of the stem; its flowers are very handsome, and bloom in May and June; and its seeds are dotted, and have snow-white reticulated tunics of an appearance like lace. The American species resembles the European, and was introduced to Britain in 1816. Both love a soil of sandy peat, and are propagated by radical division.

WINTER-GREEN,—botanically *Pyrola*. A genus of small, ornamental, evergreen, herbaceous plants, of the heath family. They take their botanical name from the similarity of their leaves to those of the pear-tree, and their popular one from the habit of remaining beautifully green throughout the winter. All are very handsome, and at the same time rather difficult to cultivate. They love a soil of sandy peat, and

thrive best in a shady border, and may be propagated either from seeds or by radical division. All possess tonic and astringent properties; and two plants which formerly belonged to them, but are now assigned to another genus, and have been noticed in our article CHIMOPHILA, are eminently medicinal. Six species inhabit the woods of Britain,—principally in moist and lofty situations; and three have been introduced from North America. All the nine have a height of about 6 inches, and bloom about midsummer or in July; and most have either white or reddish flowers, often highly fragrant. Two of the indigenous species, the rose-coloured and the intermediate, occur in England but not in Scotland; two, the side-flowering and the smaller, are semi-aquatics; one, the single-flowered, occurs only in very lofty situations; and the remaining one, the round-leaved, in common with the two non-Scottish species, inhabit ordinary woods. A curious circumstance in the natural history of the smaller species, *P. minor*, is that it has frequently been found growing in small patches in young plantations where the ground was previously in cultivation, and yet could not be discovered in previously uncultivated ground in the vicinity, even though the soil and the situation were exactly similar.

WINTER-SWEET. See MARJORAM.

WINTER WEED. The ivy-leaved speedwell, *Veronica hederæfolia*. See the article VERONICA.

WIRE-WORM. The larva of a click-beetle or elateridous insect, living in the soil, and preying destructively on the roots of cultivated plants. See the article ELATER. Four species of elateridæ, as stated in that article, have been perfectly ascertained to produce vast multitudes of the wire-worms of both field and garden; and eight other species are strongly suspected or presumptively known to produce many more; and we shall first give descriptions of all these twelve species,—next notice their general economy and habits,—and next detail the principal known means, natural and artificial, of keeping them down or exterminating them,—simply premising that, after having searched very many authorities and papers on the subject, we feel ourselves driven to rely mainly on an ample and most able article by Mr. Curtis, in the 5th volume of the Journal of the Royal Agricultural Society.

The spitting click-beetle, *Agriotes sputator*—called by Linnæus *Elater obscurus*—is the smallest of the four species which are certainly known to produce destructive wire-worms. It is shining, piceous, and clothed with very short ochreous pubescence. The head and the thorax are black, and thickly and distinctly punctured; the latter orbicular, convex, the hinder angles forming short stout teeth, sometimes rufous; and down the centre is a channel. The scutel is subovate. The elytra or wing-cases are not broader than the thorax, but more than twice as long, elliptical, convex, slightly rugose, with nine punctured striæ on each. The antennæ and legs are rufous; the former not longer than the thorax, slender, the joints obconic, the basal ones the stoutest, the second a little longer than the third, which is the smallest. The feet have five distinct joints. The length of the insect is from 3 to $3\frac{3}{4}$ lines, and the breadth from 1 to $1\frac{1}{8}$. Some specimens are entirely tawny, excepting the black eyes and tips of the mandibles; whilst others have the head and thorax only black, the hinder margin of the latter and the spines being tawny as well as the elytra. From this great difference of colour, this species was named *Elater variabilis* by Herbst; and Paykull, thinking it was the same as the next described species, gave it the name of *Elater obscurus*. It is very abundant everywhere from the beginning of May to the end of June in hedges, on grass under oaks, in corn-fields, &c.; it occurs also in profusion amongst rejectamenta left by floods.

The dusky click-beetle, *Cataphagus obscurus*—called by Linnæus *Elater obscurus*, by Eschscholtz *Agriotes obscurus*, by Fabricius *Elater variabilis*, and by De Geer *Elater obtusus*—is rather more robust than the *Agriotes sputator*, and has more convexity on the sides of its thorax. It is piceous, densely clothed with short depressed ochreous hairs. The head and the thorax are thickly and distinctly punctured; the latter is as broad as it is long, orbicular, very convex; the posterior angles are produced into strong spines, and there is a channel down the back. The scutel is oval. The elytra are not broader than the thorax, and nearly three times as long, elliptical and convex, the extremity when united conical, the apex of each rather acute, reddish brown and punctured, each having nine punctured striæ somewhat in pairs. The antennæ are a little clavate, quite as long as the thorax; the basal joint stout, the second and third of equal length, shorter and smaller than the following, the terminal one ovate-conic, reddish brown as well as the legs. The feet or tarsi are distinctly five-jointed. The length of the insect is from $4\frac{1}{4}$ lines to $4\frac{1}{2}$, and the breadth $1\frac{1}{2}$ to $1\frac{3}{4}$. The pubescence is so thick on perfect specimens as to give them a dull brown tint all over; whilst others which are old and rubbed appear blackish. From April to Midsummer this beetle is abundant in fields, pasture-lands, woods, and gardens.

The striped click-beetle, *Cataphagus lineatus*—called by Linnæus *Elater lineatus*, by Panzer *Elater striatus*, by Gyll *Elater segetis*, and by Eschscholtz *Agriotes lineatus*—is supposed by some entomologists to be only a variety of *Cataphagus obscurus*, with the elytra or wing-cases striped, the spaces between the striæ being alternately dark and light, forming four brown and five testaceous lines. It is an exceedingly common species in various situations, and is the most frequently bred from the larvæ by those who have taken the pains to rear them. In

April it has been found in great numbers under stones by the sea-shore; and in May it has been seen congregated upon a yellow ranunculus or buttercup in an osier-holt. It abounds also on grass, in hedges, corn-fields, &c.; and specimens of it have been obtained as late as July, with the pupæ and exuviæ. Bouche says that its larvæ live sometimes in great multitudes in dung and vegetable earth.

The rufous-rumped click-beetle, *Athous ruficaudis*—called by Gyll *Elater ruficaudis*, by Olivier *Elater sputator*, by Herbst *Elater analis*, and by Fabricius *Elater hæmorrhoidalis*—is long, narrow, piceous, and shining, and clothed with ochreous and longish hairs. The antennæ are dusky, and similar in their relative proportions to those of *Cataphagus obscurus*, but a little longer and compressed; the basal joint is stout, the second and third slender, the remainder obtrigonate, the apical one narrower, the tip conical. The head and the thorax are black, and thickly and minutely punctured; the former is semi-orbicular, with truncated and reflexed clypeus; the latter is much longer than broad, a little narrowed towards the anterior angles, the posterior spines short and trigonate, and the margin beneath projecting considerably in a semicircle to receive the head. The scutel is black. The elytra are reddish brown, and twice as long as the head and thorax, being rather broader than the latter, but linear, the apex ovate, and the tip of each rounded; and they are minutely punctured, with nine striæ on each. The abdomen is ferruginous. The legs are short and ferruginous. The feet appear four-jointed until magnified; and are very pubescent beneath, —the basal joint the longest, the second and third decreasing in length, slender at the base, and somewhat trumpet-shaped, the apex furnished with a membranous margin,—the fourth minute,—the fifth long, slender, and terminated by two simple claws. The length of the insect is 6 lines, and the breadth 1½ line. It is abundant from April till the end of June in corn-fields, on nettles, on commons, in pastures, &c. It has been observed in the beginning of June flying about hedges and banks, and in May infesting the oak-leaves and underwood in extensive woods.

The satin-coated click-beetle, *Lepidotus holosericeus*—called by Linnæus *Elater holosericeus*—is the first of the eight species which are but presumptively known to produce the destructive wire-worms. It is elliptical or boat-shaped, deep brown, thickly and minutely punctured, and clouded with silky ochreous pubescence. The antennæ are scarcely so long as the head and thorax, and are slightly pubescent, and eleven-jointed; the basal joint the stoutest, somewhat chopper-shaped, and chestnut-coloured,—the second minute,—the third long, slender, and clavate,—the fourth and six following produced internally and obtrigonate,—the apical joint elongate-ovate, and the apex narrowed. The head is small. The palpi and eyes are black. The thorax is convex, semi-ovate, concave before, broadest at the base, which is bisinuated, the angles produced, each forming a strong trigonal lobe, not very acute; the pectoral lobe rather small and tapering. The scutel is large and orbicular. The elytra are more than twice as long as the thorax, and scarcely broader at the middle, the ochreous pubescence often forming two ocelli on the disc; and there are nine punctured striæ on each elytron, most distinct at the base. The wings are ample. The legs are short, slender, and pale ferruginous. The length of the insect is 5 lines, and its breadth 2. This click-beetle has often been observed in corn-fields, and also found under stones and on birch-trees; and it continues from the end of April till August.

The mouse-coloured click-beetle, *Agrypnus murinus*—called by Linnæus *Elater murinus*—is rather broad and boat-shaped, and entirely clothed with very short ash-coloured depressed hairs, marbled with brown, more or less ochreous, and is thickly and minutely punctured. The antennæ are shorter than the thorax, rather stout, and eleven-jointed, of bright ferruginous colour, the basal joint stout, oblong, and piceous,—the second small and semiovate, —the third smaller and pear-shaped,—the fourth and six following compressed, produced internally, and obtrigonate, —the apical joint longer and ovate,—and the apex suddenly narrowed. The head is semi-orbicular and depressed. The eyes are scarcely visible. The thorax is twice as broad, orbicular, convex on the back, with two tubercles on the disc; beneath are two deep fissures to receive the antennæ, and the pectoral spine is long and attenuated, and the apex subulate. The scutel is ovate-conic. The elytra are a little broader than the thorax, and more than twice as long,—the hinder portion attenuated,—the apex rounded, sloped suddenly towards the thorax at the base; and there are nine indistinctly punctured striæ on each elytron, and the costal margin is deeply emarginate to receive the hinder thighs. The wings are ample. The legs are short and shining pitchy. The tips of the thighs and the tarsi are fulvous; and the latter are five-jointed and tapering,—the basal joint the stoutest and the longest in the hinder pair. The claws are moderate and acute; the tibiæ are rough, with series of minute bristles. This insect is commonly about 6 lines long and 2½ broad; but is sometimes much larger. It is found in corn-fields and in sandy places from the end of April till the early part of autumn.

The tawny-legged click-beetle, *Melanotus fulvipes*—called by some entomologists *Elater fulvipes* and by others *Elater castanipes*—is very long, narrow, and shining black, thickly punctured, and clothed with very short fine ochreous pubescence. The antennæ are as long as the thorax, compressed, pubescent, fulvous, and eleven-joint-

ed,—the basal joint stout and subpyriform,—the second minute and nearly globose,—the third small and obovate,—and the fourth and six following, produced internally, and obtrigonate, but slightly decreasing in diameter to the apical joint, which is spindle-shaped. The mouth is pale ferruginous, the labrum and tips of mandibles piceous. The head is rather broad, and semiorbicular. The eyes are hemispherical; the clypeus forming a sharp projecting shelf over the mouth. The thorax is convex, somewhat semiovate, and almost straight before,—the base nearly straight also, the angles forming rather narrow lobes, and appearing pointed above, but truncated laterally; there is also a dorsal impression broadest at the base, and a short longitudinal channel on each side, close to the lobes. The pectoral spine is rather long and narrow. The scutel is tongue-shaped. The elytra are thrice as long as the thorax, but not broader, linear, the apex subovate; and they are more finely punctured than the thorax, and there are nine punctured striæ on each. The costal margin is gently hollowed towards the base. The wings are ample. The legs are moderately long, and chestnut coloured. The tarsi are tapering,—the basal joint the stoutest, and a little elongated,—the fourth small. The claws are minute. This species varies in length from 6 to 9 lines, and in breadth from $1\frac{3}{4}$ to $2\frac{3}{4}$. It sometimes abounds in corn-fields, and in hedges and grassy places, and appears in May, June, and July; but its larvæ live in decaying trees, and probably do little injury to crops.

The reddish-brown spitting click-beetle, *Agriotes sputator* or *Elater sputator*, is confounded in name with one of the four species whose larvæ are certainly known to be devastating wire-worms, and is nearly allied in natural characteristics to the dusky click-beetle or *Cataphagus obscurus*. It is clothed with short depressed ochreous pubescence. The antennæ are scarcely so long as the thorax, compressed, and pubescent,—the basal joint stout,—the second rather longer than the third, which is oval,—the remainder short and obovate,—the terminal joint elongated,—the apex conical. The head and thorax are black, shining, and thickly punctured; the anterior margin of the latter, and the hinder lobes, reddish-brown. The head is somewhat orbicular; the clypeus narrowed. The thorax is longer than broad, narrow, oblong, very convex, with a dorsal impression behind, the posterior angles forming truncated lobes. The scutel is oval, and truncated at the base. The elytra are not broader than the thorax, and twice as long, nearly linear, the apex ovate; and they are somewhat scabrose, with nine striæ on each, not neatly punctured, and deepest at the base,—the costal margin very concave towards the base. The wings are ample; the under side castaneous-brown. The angles of the thorax and the pectoral spine, which is rather long and slender, are ferruginous. The legs are moderate and slender; feet tapering,—the basal joint a little elongated; the claws slender. The length of this insect is 3 lines, and the breadth 1 line. The colour varies considerably, some specimens being entirely bright ochreous, whilst others have the head and thorax partially variegated with black. This species abounds in grass fields, and feeds in company with the dusky and the striped species. The perfect insects of it occasionally occur in multitudes in the rejectamenta left by floods in the fen districts of England; and in the months of spring and summer, they are abundant everywhere.

The black click-beetle, *Athous niger*—called by Linnæus *Elater niger*—is boat-shaped, shining black, finely punctured, and clothed with yellowish pubescence, which is not depressed. The antennæ are longer than the thorax, compressed, tapering, and hairy, the basal joint stout,—the second minute and ovate,—the third obtrigonate,—the following similar but larger, produced on the inside, but decreasing towards the apical joint which is fusiform. The head is suborbicular; the clypeus forming a projection over the trophi. The thorax is twice as broad, oval, very convex, the posterior angles not acute, a little divaricating; the pectoral lobe not long and tapering. The scutel is ovate-trigonate. The elytra are broader than the thorax, elliptical, the apex ovate or sub-conical, with nine punctured striæ on each, most distinct at the base. The wings are ample. The legs are not long. The thighs are stoutish; the three basal joints of the tarsi cushioned beneath,—the second and third dilated,—the fourth minute,—the fifth slender,—the claws small. This species is from $5\frac{1}{2}$ to 6 lines long, and from $1\frac{3}{4}$ to 2 broad. It is very abundant, during May and June, in corn-fields, hedges, and meadows; and it is said to live two years in thoroughly rotten or highly decomposed horse-dung, so that its larvæ or wire-worms may often be conveyed in this kind of manure into fields and gardens.

The margined click-beetle, *Dolopius marginatus*—called by Linnæus *Elater marginatus* and by Marsham *Elater saturalis*—is narrow and elliptical, shining, testaceous, and clothed with short ochreous pubescence. The antennæ are longer than the head and thorax, slender, compressed, fulvous, and pubescent,—the basal joint the stoutest and clavate,—the second and third the slenderest and elongated,—the fourth and following stouter and clavate,—the terminal joint subfusiform. The head and thorax are thickly and strongly punctured; the former obtuse, convex, and pitchy; the latter longer than broad, very convex, piceous, the anterior and posterior margins bright ochreous, including the angles, which are very acute and slightly divaricating. The scutel is subovate. The elytra are linear, thrice as long as the thorax, sometimes rather broader, attenuated or ovate behind, ochreous or reddish brown, with a space down the suture,

and sometimes the costal margin brown; they are somewhat scabrose, with nine distinctly punctured striæ on each, the outer margin slightly concave towards the base. The wings are ample; the under side more or less fuscous or castaneous. The pectoral spine is long and narrow, but thick. The apex of the abdomen is testaceous. The legs are moderately long, slender and pale ferruginous; the tarsi, with the terminal joint the slenderest, the basal joint elongated; the claws minute. The total length is $3\frac{1}{4}$ lines, and the breadth $\frac{3}{4}$. This is an exceedingly variable species in outline and colour, some specimens being broader than others; and the antennæ are apparently stouter in the males. Some examples are entirely bright ochreous or chestnut, and others are uniformly of a pitchy colour. It abounds, in June, July, and August, upon oaks and alders in woods, and is not infrequent in corn-fields; but its peculiar habits or economy as a species are altogether unknown.

The pointed click-beetle, *Adrastus acuminatus* or *Elater acuminatus*, is almost a miniature of the preceding, and is about the same size as the *Elater limbatus* of Linnæus, but has a narrower and less convex thorax, and is generally marked with a sort of shallow groove down the crown of the head. It is elliptical, narrow, shining, testaceous, and clothed with short ochreous pubescence. The head and thorax are black and punctured; the latter longer than broad, the anterior margin and posterior angles acuminated and testaceous. The antennæ are longer than the head and thorax, compressed, and castaneous,—the basal joint elongated and stout,—the second and third obovate, the latter a little the shortest,—the fourth and following somewhat obovate, truncate,—the terminal joint fusiform. The scutel is dark and oval. The elytra are nearly thrice as long as the thorax, punctured, testaceous, the suture often dusky, especially near the apex, with nine punctured striæ on each; the underside piceous; the pectoral spine long and slender; the legs ochraceous. The total length is about 2 lines, and breadth about $\frac{1}{2}$. This species frequents corn-fields, meadows, hedges, and similar situations; but whether its larvæ belong to the destructive wire-worms has not been ascertained.

The long-necked click-beetle, *Athous longicollis* or *Elater longicollis*, frequents corn-fields, hedges, grassy grounds, and woody places from April till August. The male is long and narrow, ochreous, and clothed with very short pubescence of the same colour. The head and thorax are thickly and coarsely punctured, and of a dull black colour; the anterior margin of the latter, the sides and base, including the angles as well as the clypeus, are more or less ferruginous in many examples; and this portion of the head is very concave, the margin thickened and slightly reflexed. The antennæ are more than half the length of the body, slender, and compressed; the basal joint is clavate, and not stouter than the following, which are elongate-clavate, and truncated, excepting the second, which is minute, and the terminal joint, which is subfusiform. The head is subquadrate. The eyes are very prominent. The thorax is long and narrow, not much broader than the head before, gradually and slightly increasing in diameter to the base; the angles short and truncated laterally; the sides nearly straight, but slightly convex near the middle; and down the back is a faint channel, with a slight fovea on each side near the base. The pectoral spine is long and slender. The scutel is small, black, and punctured. The elytra are more than twice as long as the thorax, and a little broader, linear, the apex ovate, the costal margin fuscous and very gently concave near the base; they are slightly glossy, a little rugose, with nine distinctly punctured striæ on each. The wings are ample. The underside is more or less piceous, excepting the body, which is ochreous and very glossy, sometimes pitchy down the centre, or having two fuscous spots on each segment. The legs are longish, slender, and of a deep ochreous colour; the tarsi tapering, the basal joint elongated, the fourth minute. The total length is $4\frac{1}{4}$ lines, and the breadth rather more than one line. The female differs so considerably from the male in form that the name of *longicollis* is not appropriate. The neck is much broader and larger; the antennæ are not so long, the third and following joints being obtrigonate. The female varies also greatly in colour, some specimens being entirely brown, others of an ochreous-chestnut, &c.

The eggs of the click-beetles are very minute, of a yellowish-white colour, and nearly globose or slightly oval. Whether they are laid in the soil close to the root of a plant, or between the sheaths or enveloping leaves near the base of the stem, has not been ascertained. The larvæ must at first be almost invisible to the naked eye; they grow very slowly, and become when full grown about three-fourths of an inch, or in rare cases eleven lines, in length; they have a wire-like form, a smooth surface, and extreme toughness,—and thence are called wire-worms; and they live five years in the proper state of larvæ, and cast off their skin, probably at three successive periods, as they increase in size. They perform their moult by splitting the skin along the thorax, and drawing themselves out at the aperture; and their exuvia has a brown colour, and retains the form of every part of the body, including eyes, horns, feet, and perhaps also internal organs. The larvæ, immediately after the moult, are very tender and of a whitish colour; but as soon as they recover, they move about with the greatest facility; and in all their ordinary states, they have a perfect adaptation of skin for free and agile diving into the soil, burrowing in the earth, and gliding upward and onward in any direction they please.—A wire-worm has a pale ochreous colour, becoming darker when dead, with a few

hairs scattered over its polished shining skin. It is semicylindrical, the back being convex, the belly more flat. Its head is flattened or wedge-shaped, and there are twelve abdominal segments. The mouth is rather small, and comprises an upper-lip, with a horny base, the margin leathery and bilobed; it is small and concealed beneath the clypeus, which is rigid, with a ciliated lobe on each side, and three minute teeth in the middle; beneath is a large semiovate space formed by the union of the base of the maxillæ with the mentum or chin, which is long and narrow; the under-lip is small and somewhat obtrigonate, the base truncated, the margin undulating and furnished with two small biarticulate palpi or feelers, sometimes with an indistict third joint; on either side is the maxilla, having a minute and densely pubescent lobe on the inner angle, with a larger biarticulate one behind it, and a four-jointed palpus or feeler on the outside, the terminal joint the smallest; above these are the mandibles or jaws, which meet over the mouth, one being placed on each side,—they are strong, horny, and of a pitchy colour, being more or less pointed, with a tooth below the apex, and frequently a smaller one at the middle,—and below this is a ciliated space. Two little antennæ or horns are placed in front of the head near the anterior angles; they are triarticulate and similar to the palpi in form, the basal joint being the largest, the terminal one short and slender; and sometimes there is a tubercle projecting from one of the angles of the second joint. On each side of the head and behind the antennæ is a minute dot like a little eye. The first abdominal segment is much longer than the two following; the eight succeeding have a minute spiracle on each side; the terminal one is the longest and conical, with a brown or blackish oval aperture, larger than the others on each side towards the base; beneath this segment is also a false leg or prehensile foot, which assists in walking, and is probably the vent for the evacuation of the digested food. The three first or thoracic segments are furnished with six short legs, a pair being attached to each near the hinder margin; and these are nearly alike and four-jointed, the joints being rough with short brown spines, the apex furnished with a strong claw, slightly curved and nut-brown. When the wire-worm has arrived at maturity, it descends a considerable depth into the earth, and forms an oval cell there entirely composed of the surrounding particles of soil, and not even lined with silk; it then casts its skin again, and becomes a pupa or chrysalis, generally, it seems, at the end of July or beginning of August.—The pupa is long and narrow in form, like the perfect insect, but is of a yellowish-white colour. There are two minute spines projecting from the anterior angles of the thorax; all the oral organs are visible; the horns and legs are folded or incumbent upon the breast; and the wing-cases as well as the wings are small and the least developed of any part; the scutel and abdominal segments are distinct, the apex being furnished with two moveable spines and two lobes terminated by nipples in the middle beneath. Of course at this period the animal is at rest, being deprived of the power of locomotion, and is consequently no longer injurious. The insects commonly remain in the pupa state two or three weeks; but many no doubt pass the winter buried and protected from casualties and the rigour of that inclement season. When the appointed time for their transformation comes, they burst from their shrouds and earthy tombs, and rising through the soil arrive at the surface changed to perfect beetles, but of a whitish colour, soft, and extremely tender; and after being exposed to the air and light, their bodies harden and their colour gradually changes, so that in a few hours they attain their horny coat, their specific colour, and all their permanent characters.

Wire-worms occur in most land, and attack almost all kinds of crops; but they specially abound in some particular conditions of soil and in some particular situations, and they greatly prefer certain plants to others. The tastes of individuals of different species, and those also of different ages of the same species, probably differ; so that, though all the specimens which can be obtained in any field or garden may seem to be perfectly like one another in every thing but size, several entirely distinct kinds, with appreciably different habits, or even with powers of mischief ancillary and supplementary to one another, may be simultaneously carrying on the work of devastation. Wire-worms are particularly rife on land which has lain long fallow, and on ploughed land newly or recently broken up from old pasture or from clover ley; they seem specially to multiply from the undisturbed deposition and hatching of their parents' eggs on grass lands and wastes, and from the free supplies of food afforded them by grasses, weeds, and all sorts of luxuriant, perennial, herbaceous vegetation; and, within the sphere of cultivation, they prey most on oats, wheat, barley, artificial grasses, turnips, carrots, mangel-wurzel, rape, cabbages, potatoes, onions, lettuces, hops, irises, carnations, pinks, lobelias, and a multitude of the most common ornamental plants of the flower-border. So many as from four to eight wire-worms have been turned up by the spade in a space of four feet; and so many as from four to twenty plants have been observed to be bitten in a very short time by one worm.

The most important crop which suffers from the wire-worm is wheat. A writer in the Linnæan Transactions, speaking of this in cases of sowing upon clover leys, recently broken-up old pastures, and pea and bean stubbles, estimates it at about a twentieth part of the whole, and thinks this a very fair and moderate calculation. "The number of cultivated acres of land in England at the time in question," says he, "was

computed at seven millions, of which 2,400,000 were calculated to be sown with wheat, and as only one-half of the wheat sown is supposed to be on clover leys, old pastures, &c., our calculations must be confined to 1,200,000 acres, instead of 2,400,000; this will give 60,000 acres as annually destroyed by the insect in question, which replanted, at one bushel per acre, will require 60,000 bushels of seed, which, at 8s. per bushel, are worth £24,000. Besides this, although no extra expense is incurred by the farmer in preparing the land, yet he has to pay for dibbling-in the seed, which, at 5s. 3d. per acre, will cost £15,750, or at the full price, 6s. per acre, £18,000. If the land require harrowing, there will be a further charge of 9d. per acre, or £2,250, not to name other items, which render it difficult precisely to ascertain the loss of the farmer. If the above calculation be thought a fair one, and I see no reason why it should not, we find the quantity of wheat lessened to the market by the depredations of these insects is very frequently, if not annually, 60,000 bushels, which occasions to the farmers an additional expense of at least £15,750." Instances are frequent of a far greater proportion of wheat crops being destroyed than this calculation supposes; and even a case of the most excessive destruction has not been a-wanting,—so excessive as to require the whole field to be ploughed up. The attacks, in general, do not seem to begin till spring,—though they have been supposed by some observers to be made also during the winter; and they are indicated by the dying off of the lower leaves,—and in the worst cases by the falling of the plant.—Oats, in consequence of being a favourite crop on newly broken up leys and pastures, are oftener devastated to an excessive extent than wheat. Dr. Dickson says, "When this sort of grain is cultivated on such leys as are newly broken up, there may frequently be danger, especially where the land has been long in the state of grass, both from the destructive attacks of insects, and the soil becoming too light, open, and porous, from the decay of the grassy materials for the support of the plant." The discouraged farmer, in fact, is sometimes compelled to lay down valuable land as pasture to a very great disadvantage; and in 1842, in many parts of England, the oat-crops suffered so severely from the ravages of the wire-worms, that it became necessary to plough them up and sow a second time.—When the season is dry and cold in the early spring months, the barley-crops are frequently greatly injured by the attacks of the wire-worms; and this is indicated by the young plants changing from a healthy green to a sickly yellow.—Potatoes greatly suffer in some districts, and do not suffer at all in others. This is a very remarkable fact, and resembles the curious anomaly in the habits of the black caterpillar, which in some districts will not touch Swedish turnips and in others will not feed on anything else; and hence one writer asserts that the wire-worm will not injure potato crops, while others assert that, in many localities, it has annually reduced them to less than one-third.—Crops of cabbages, also, whether in the field or in the garden, are sometimes greatly ravaged or almost totally destroyed; and crops of carrots, in kitchen-gardens, which have not undergone proper rotations, or which have been suffered to lie in a rank and weedy condition, are often so inveterately attacked that entire series and successions of them more or less completely fail.—The turnip, however—even notwithstanding its being the prey of so many other insect enemies—suffers more severely from the wire-worm than any other green crop; and is attacked by it in the foliage as well as in the root, and at all seasons of the year except during frost; and is deprived of as much substance by one individual of it as by five or six turnip-flies. "The wire-worm," says Mr. Le Keux, "begins on the edge of the leaf and eats it away like a caterpillar, and often cuts the leaf off at the top of the stalk, and it may sometimes be found on the ground half devoured. The wire-worm," he states, "seldom feeds above ground in the day-time, unless it be cloudy and dark. At such times I have observed them devouring the young turnip plants before the rough leaf has been formed; but their most destructive operations are carried on beneath the surface of the earth, where they attack the root; in the very early state of the plant, after eating this through, the upper part of the plant is gradually drawn down into the earth and devoured, so that the plants disappear without any perceptible cause, and without any trace of them being left. In the more advanced state of the plant their devastation appears to be confined to eating through the root; and having thus killed one plant, they proceed to another. If a turnip-plant appears drooping (as if from the want of water), whilst those in its neighbourhood are fresh and erect, a wire-worm (sometimes half-a-dozen) will be sure to be found at the root, if the earth around it be carefully removed."

Wire-worms are to the full as mischievous in the garden as in the field; and, in consequence of the great variety of plants attacked by them, they are a kind of universal plague to at once the cottage cultivator, the market-gardener, the nurseryman, the orchardist, and the florist. Those of the spitting click-beetle and the dusky click-beetle are particularly abundant and wondrously destructive; and as the former of these beetles is strongly attached to umbelliferous flowers and to nettles, all classes of cultivators ought vigilantly to keep down fool's parsley, hemlock, and all similar weeds on the banks and hedges in the vicinity of their grounds. In the garden as in the field, the wire-worm is particularly destructive for a few years after ground has been broken up from pasture; and, at a time when the Botanic Garden at Hull was in this condition, it de-

stroyed a large proportion of the annuals sown in it. Pansies, lobelias, and dahlias are much attacked by it; and all the fine kinds of dianthuses are peculiarly liable. "The wire-worms," says Mr. Smith in the Florist's Magazine, "invariably attack the pink and the carnation at the bottom of the stem near the root, and make holes through it in every direction, while the only indication of their presence is the entire destruction of the plant. The larva is in general found in the loam; therefore great care should be taken, in sweetening that soil, not to allow one to escape when it is turned over; and their colour being a light brown, makes the finding of them more difficult."

As to the particular soils and seasons and circumstances in which the wire-worms are most mischievous on farm-lands, the following important information is presented by Mr. Curtis:—"Mr. Porter of Covehithe, where the lands are for the most part light, says that the wire-worms do most mischief in March, April, May, and June; that wheat suffers the most among the corn-crops, and white turnips amongst the green crops, but that rye is sometimes swept off by acres; and with regard to barley, he has observed that when it is drilled-in 3 inches deep, the plant droops and turns yellow, as if attacked by the wire-worm, whereas at 1½ inch deep it makes a vigorous plant. I may observe with respect to this difference of result from the depth of sowing, that it is possible the wire-worm may not be able to exist near the surface in a light sandy soil, and consequently the barley escapes when drilled-in at the lesser depth. Turnips and beet-root he finds most affected at the end of June and the beginning of August; yet 12 acres of the latter, which produced a fine plant, were completely taken off by the wire-worm the last week in May. Swedes were afterwards sown the second week in June, and to his surprise produced a fine crop. The success of the swedes must be attributed, I think, to the greater part of the wire-worms having arrived at maturity when they had destroyed the beet, in which case they would change to pupæ, and afterwards to beetles, in both which states they are harmless. Turnips do best at Covehithe if sown about the 21st June on the light lands, and a week earlier on heavy lands. On the lower part of fields bordering on marshes, where the land is springy and friable, barley, turnips, and beet have generally fallen a sacrifice; and such land is most subject to their attacks. When white-clover or suckling and rye-grass layers have been left for seed, it is scarcely possible to get a wheat-crop on account of the wire-worm; the only chance is to break up the land and work it well about for a couple of months in the autumn. Potatoes never suffer on Mr. Porter's farm from the wire-worm.—Mr. Robinson, of Henstead, informs me that in his neighbourhood the gravelly and sandy soils are most infested, and the strong loam and clay most free from the wire-worms. That they inhabit every aspect was proved by their ravages over all parts of a field which was lowest in the centre. A dry season is most conducive to their increase; yet if the following year be wet, it does not kill the wire-worms, but it probably destroys the elaters, and prevents the deposition of the eggs. Early in March 1841, when his wheat was well out of the ground, and about 1½ inch high, it began to die off, and on pulling some up he found the wire-worm had eaten into the stalk and consumed the inside. This was upon dry gravelly hills which had been a clover layer, and the valleys and better parts of the field did not suffer; but barley on strong land in the same parish drilled in the spring, did not produce above one-third of a crop, owing to the attacks of the wire-worms. Some low wet common land was broken up, pared and burnt (which with the draining cost £10 per acre); it first produced a good crop of turnips, and afterwards a prodigious crop of oats; but another portion under a different owner was pared but not burnt, and the crop was lost. —Mr. Bates says that the following is the order in which the crops probably are affected in degree in his part of Suffolk, viz., wheat, turnips, barley, oats, and beet, and that they are generally least injured on good soils. If wheat be sown in dry weather, it has proved favourable to the inroads of the wire-worm. Oat stubble ploughed several weeks previously, and sown with wheat the third week in November, suffered from their attacks. Barley and oats were injured in May, in a cold wet season. Turnips have been swept off after being up a fortnight, but generally they fall a sacrifice when three or four weeks old, having at that time four or six leaves; yet he finds the eating through of the tap-root after the second hoeing does little mischief to the turnip-plant. That all lands exposed to the sun by being fed off short, as clover layers, are greatly infested with the wire-worms, but that no potato-crop is destroyed by them."

Three of the most effectual preventives of the ravages of wire-worms are judicious fallowing, the judicious breaking up of leys and pastures, and the judicious surface treatment of ploughed lands. "May not this insect," said a perspicacious writer in 1816, "which is now more prevalent among our crops than ever, owe its prevalence to the system of fallowing and burning the refuse of such crops being nearly exploded?" A clean and careful summer fallow, in fact, when accompanied with such a thorough burning of rubbish as will surely destroy both the larvæ and the eggs of the click-beetles, is a perfect remedy against wire-worms wherever they have been working devastation; and if it occurred at regular though even pretty remote intervals in a cycle of years, would always be a more or less powerful hindrance to their obtaining any lodgment. In every case, however, it must be truly clean and careful,—and in particular must completely clear

away all couch-grass and similar weeds, whose roots might afford sufficient sustenance to a large number of the wire-worms till the corn crop should be sown and strike root. See the article FALLOW. Any pasture or old ley intended to be broken up for corn should be carefully examined; and if any considerable proportion of wire-worms are found in the roots and stems of its plants, it should either be sown with some substances fatal to them at the time of breaking up, or subjected to a searching summer fallow previous to the sowing of it with corn. In breaking up any old pasture, where so extreme a precaution as either of these may be thought unnecessary, a breast-plough should be used to take off not more than 2 inches of the turf in the first instance, which will secure the crop from the attacks of the wire-worm, for an additional depth of only 2 inches has so encouraged that pest that it has been known to destroy an entire field of wheat. This difference probably arises from the effects on the roots of the grass; if the top of the turf only be pared off, the roots will die, whereas by going 4 inches deep they lie and vegetate, so that when it is afterwards all ploughed-in, the worms find the requisite pabulum, until the corn is forward enough to afford the wire-worms a more agreeable substitute. Dr. Dickson says that the destructive attacks of insects on leys newly broken up "may in some measure be obviated by eating such lands very closely with sheep previous to their being broken up, as by such a method the ova of such insects may be much destroyed and their propagation prevented; and the treading the crop by sheep as well as the roller may likewise be beneficial; horses have also been turned in for the same purpose by some cultivators." The folding of oxen and sheep upon infested fields is supposed by many to check the wire-worm by stopping their burrowing; but it seems more likely to prevent the beetles from being able to get out of the earth from their pupæ cases, and to compel those which do effect their escape, in consequence of their finding no appropriate place for the deposition of their eggs, to depart for a more suitable locality. This operation might therefore be most advantageously adopted early in the spring before the beetles hatch. An eminent cultivator preserved his turnips by harrowing and hard-rolling the land in March and April, but found this operation of no use later in the season. In another place, alluding to barley, Dr. Dickson also says, "If the plants suddenly change from a healthy green to a yellow cast, the use of the roller should be had recourse to, in order that the superficial parts of the soil, which are probably become too loose and porous, may be effectually pressed, and thereby rendered too close and compact to admit the worm to prey upon the tender roots of the young plants. That this effect may be produced in the most effectual manner, the roller should be of such a size, or so loaded, as to afford a pressure equal to the draught of three or four horses, which should be yoked double, in order to increase the effect by their treading. It has been suggested that if by this method the injury can be counteracted until such time as rain falls, there need not be any apprehension for the crop, as the plants will soon push forward in such a manner as to become too strong to be in danger from this insect." The use of some of the recently-invented rollers, of the clod-crushing and soil-biting kind, particularly Crosskill's, is still more eminently serviceable; and a top-dressing of lime before using the rollers, whether they be of the old kind or the new, materially adds to the efficiency.

A good remedy for wire-worm may be found in a crop which, while taking entire possession of the soil, either affords no proper nourishment for the larvæ or contains some principle which operates fatally on their life; so that, while excluding every other plant on which they might feed, it shall exterminate them either by starvation or by poisoning. Two crops of this kind are woad and white mustard. On breaking up damp meadow and pasture land in Lincolnshire, the sowing of it with woad instead of corn has been found to exterminate wire-worms; and in the ordinary rotational management of arable land, the sowing of it with white mustard preparatorily to corn, will destroy all the wire-worms by which the corn would otherwise be infested. "White mustard-seed," says Mr. Tallent of Little Houghton, "will protect the grain from the wire-worm, and this fact I have demonstrated perfectly to my own conviction. I first tried the experiment on half an acre, in the centre of a 50-acre field of fallow, which was much subject to the wire-worm. The mustard-seed being carried, the whole field was fallowed for wheat, and the half-acre that had been previously cropped with mustard-seed was wholly exempt from the wire-worm; the remainder of the field was much injured. Not only was the half-acre thus preserved, but in the spring it was decidedly the most advanced part of the crop; and the prosperous appearance which it presented caused me to repeat the experiment, by sowing three acres more of mustard-seed in the worst part of a field of 45 acres, also much infested with the wire-worm. The remainder of the field was sown with early frame pease, which, with the mustard-seed, were cleared in the same week. The land was then ploughed for wheat; and I had the pleasure of noticing these 3 acres to be quite free from the worm, and much superior in other respects to the other part of the field, which suffered greatly. Thus encouraged by these results, I sowed the next year a whole field of 42 acres, which had never repaid me for nineteen years, in consequence of nearly every crop being destroyed by the wire-worm; and I am warranted

in stating that not a single wire-worm could be found the following year, and the crop of wheat throughout which was reaped last harvest was superior to any I had grown for twenty-one years. I am therefore under a strong persuasion that the wire-worm may be successfully repelled and eradicated by carefully destroying all weeds and roots, and drilling white mustard-seed, and keeping the ground clean by hoeing."

Another good remedy for wire-worm would be the application to the soil, in the way of sprinkling, top-dressing, or intermixture with manure, of some substance which, without injuring the plants or deteriorating the land, will kill the larvæ. More carefully conducted experiments, and on a more extensive scale than any that have yet been undertaken, will be necessary to show what kind of substance is best adapted for this purpose. Probably different substances will be found most useful in different situations, according to the nature of the soil and the chemical ingredients which enter its composition. The latter consideration should be particularly attended to in all experiments on the subject, as most likely to suggest the most appropriate remedy; and it might even happen that the substance employed to destroy the insects might be so managed as to produce a most beneficial change in the chemical qualities of the soil. If a strong saline solution, for example, should be found to kill the insects, as it is very likely to do, there are few soils which would not derive benefit from it. Of course many substances prove speedily fatal to wire-worms, and among these the choice would have to be determined by cheapness and ease of application. Beirkander, a Swedish observer, who has investigated the habits of wire-worms, found that they live 9 days among garlic, 14 hours among spruce leaves, 12 hours among fir leaves, 9 hours among *Ledum palustre*, and 2 hours among *Myrica gale;* and he suggests that such of these plants as prove most speedily fatal should be mixed with the manure. Several liquid applications have been tried with more or less success in gardens, —principally, however, in flower-gardens, and under circumstances widely dissimilar from all field cultivation; and the chief of these are spirit of tar, chloride of lime water, and some strong saline solutions. Lord Albemarle recommends that when a field intended for wheat is infested with wire-worms, rape-cake should be used as a manure, to be pulverised and sown across the field; and if this do not destroy the insects, it at least saves the crop from their attacks. Mr. Burgess, writing in the second volume of the Royal Agricultural Society's Journal, says, "This year I applied the nitrate of soda to my wheat, when, from the wet season and the wire-worm, the plant was nearly destroyed, and I found it particularly beneficial, the wire-worm either being killed by the application or forsaking the roots; and consequently I think I have above an average crop of wheat." The ammonia which invigorated the plants at the same time destroyed the insects; and it is added that the turnips grew so fast that they soon got out of the way of the fly, *Altica nemorum*. It is also positively affirmed that if lime and soot be applied to the soil before sowing any grain, it will kill the wire-worms. Common salt likewise, on light sandy soils, is highly efficacious in destroying them; and of its effects upon these animals it is in the power of every one to convince himself, and also of the strength required for their destruction, by dissolving a tea-spoonful or more of salt in a tea-cupful of water, with some wire-worms in another, half full of pure water, when, by gradually adding the salt water, the exact effect produced upon the life of the animals will be ascertained; and the same of course may be done with spirit of tar, or with any other liquid application. Wire-worms die in five minutes in alcohol, and almost instantaneously in oil of turpentine.

An excellent remedy for wire-worm in the plots and borders of the flower garden, is to lay slices of potato, turnip, carrot, beet-root, parsnip, apple, cabbage, or broccoli, as baits, on or near the surface of the soil, or to plunge potatoes, carrots, beet-roots, or parsnips, at intervals, and periodically take them up, hand-pick them, and replunge them. The Editor of the Gardener's Gazette, speaking of beds of pinks and carnations, says, "We have completely eradicated every worm from two or three beds very much infested, by plunging full-grown carrots, about 6 inches apart, and drawing them every morning. At first we found three or four worms at every carrot, and even during that period they attacked nothing else. After three or four weeks we could find none. We, however, do not think the garden generally was infested, but that the ten or fifteen loads of compost brought in for the beds, or some portion of it, may have been full of them. We had also, once a serious falling off in a tulip bed, and suspected wire-worm; adopting the same remedy, that is, plunging a few carrots, we took out enough to have destroyed the whole bed had they been neglected. Whether difference of soil or situation, or the presence of other matter, would make a difference, we know not; but we believe this little pest to prefer a carrot to anything, and, as they can work their way a third of their length into the root in a comparatively short time, when the root is drawn, they come out with it, for they cannot extricate themselves. There is nothing required but to pull them out and destroy them, and replace the carrots in the hole."

One of the best remedies in the field is hand-picking. Bierkander, after all his experiments, appears to have depended most upon this; for he says, "In a field where rye was intended to be sown, I last autumn (1778) employed a child to follow the plough and pick up the worms; by

this means 351 were collected in a piece of land 600 feet long and 56 broad. The quantity which was taken in other fields was not counted. There were caught in the furrows, according to their length, 4, 6, 10, to 14 worms. It would be serviceable if children always followed the plough and gathered these yellow worms into a bottle; they would by that means be considerably diminished, and perhaps in time entirely exterminated." "A striking instance of the use of hand-picking," says Mr. Spence, "appeared in the 'West Briton,' a provincial paper, in November, 1838, stating that Mr. G. Pearce, of Pennare Goran, had saved an acre and a half of turnips, sown to replace wheat destroyed by the wire-worm and attacked by hosts of these larvæ, by setting boys to collect them; who, at the rate of 1½d. per 100, gathered 18,000; as many as 50 having been taken from one turnip. Thus, at the expense of only £1 2s. 6d., an acre and a half of turnips, worth from £5 to £7, or more, was saved; while, as the boys could each collect 600 per day, 30 days' employment was given to them at 9d. per day, which they would not otherwise have had."

A number of birds, both tame and wild, are greedy destroyers of wire-worms; and some may be entirely encouraged in their warfare against them, and others occasionally or limitedly according to circumstances. The chief are ducks, turkeys, common poultry, pheasants, partridges, plovers, blackbirds, thrushes, robins, wagtails, and, above all, rooks. "Wary as the rook is on most occasions," says Mr. Curtis, "he follows the plough fearlessly, to feed upon the wire-worms and other insects; and here his services are most invaluable, for if you dig up the wire-worms and lay them upon the earth, they will often burrow down and disappear in a few seconds; many, therefore, of the feathered race have little chance of catching them in the ploughed field; but the form of the bill, combined with the strength and assiduity of the rook, is well adapted for detecting them in their hiding-places. To pick them from the growing crops is likewise the occupation of the rook when we see him gravely surveying a turnip or corn crop, and with astonishing sagacity selecting those plants only which have a few yellow leaves outside, the sure indication of the presence of the wire-worm and other insects. A gentleman in Norfolk, who well understands this subject, says, 'The rooks convey the first tidings of the presence of this formidable enemy by hovering over a field in flocks, and actually pulling up the turnips by the roots to search for them, and I cannot but believe that their sagacity directs them to the infested plants, which are distinguished by their drooping leaves and dark unhealthy aspect.' An equally observant friend, in Surrey, says, 'The rooks are accused of doing injury by pulling up the wheat, but I, as well as others here, believe that they pull up the attacked plants to get the wire-worms, and do not touch the healthy plants.' The bailiff to the same party informed me, during a period when the wire-worms were abundant, that the rooks had been busily occupied amongst the barley in May, and where it looked sickly had drawn the earth away from the roots to find the wire-worms, and where they had been 'working the earth' he could not find any of the worms. But there is still stronger and incontrovertible evidence in their favour; for in the stomachs of rooks which have been shot when following the plough in barley-sowing, a few grains of corn only were found, but abundance of wire-worms and other insects. Mr. J. Denson, sen., says, 'I have repeatedly examined the crops of rooks: in six young that had been shot, the crops were nearly filled with wire-worms; in the crops of others, I have found the larvæ of the cockchafer, and other grubs that I am not entomologist enough to know the names of. In one or two instances, in frosty weather, I have examined the crop of one or more rooks that had been shot; it contained dung, earth, and a small portion of grain. I will just notice that the land adjoining Mr. Wiles's rookery is yearly sown with pulse or grain, and in no instance have I known or heard that the land has in consequence failed of a crop.' The following remarks also, by Mr. T. G. Clithero, are exceedingly interesting:—'In the neighbourhood of my native place, in the county of York, is a rookery, belonging to W. Vavasour, Esq. of Weston, in Wharfdale, in which it is estimated that there are 10,000 rooks; that 1 lb. of food a-week is a very moderate allowance for each bird, and that nine-tenths of their food consist of worms, insects, and their larvæ; for although they do considerable damage to the fields for a few weeks in seed-time and a few weeks in harvest, particularly in backward seasons, yet a very large proportion of their food, even at these seasons, consists of insects and worms, which (if we except a few acorns and walnuts in autumn) compose at all other times the whole of their subsistence. Here, then, if my data be correct, there is the enormous quantity of 468,000 lbs., or 209 tons, of worms, insects, and their larvæ, destroyed by the rooks of a single rookery in one year. To every one who knows how very destructive to vegetation are the larvæ of the tribes of insects, as well as worms, fed upon by rooks, some slight idea may be formed of the devastation which rooks are the means of preventing.'"

WISP. A small hand-bunch of hay or straw, used for rubbing down horses and cattle, or for any similar purpose.

WISTARIA. A small genus of ornamental exotic plants of the kidney-bean division of the leguminous order.—Consequa's species, *Wistaria Consequana*—called by some botanists *Wistaria sinensis*, and by others *Glycine sinensis*—was introduced to Britain from China in 1816; and is

one of the most ornate ligneous climbing plants in the world. It somewhat resembles the laburnum in its habit of inflorescence,—with the important difference that its flowers are delicately blue; and it is almost as handsome in its foliage as in its bloom, and possesses the most wondrous power and prolificity in dispreading its branches over trellises and roofs in any style of training which fancy can desire. It has already, for some years, formed a gorgeous ornament athwart the surfaces of greenhouses and warm walls in many parts of Britain; and, as it constitutionally possesses considerable hardiness, and may be expected to become still hardier by acclimatation, and is very facilely propagable by layering, it probably may, in the course of some years, supersede the ivy and the honeysuckle and the clematis, or at least share with them, in decorating the walls of farm-houses, cottages-ornées, and entrance-lodges. It begins to bloom in the latter part of May, or about the same time as the laburnum; and it usually produces a small second crop of flowers, and sometimes even carries a third crop in August. A plant of it at Coughton Court, the seat of Sir Charles Throckmorton, Bart., when only of seven years' growth, at the beginning of June, covered 905 feet of wall, and was 116 feet in length, and carried 2,275 blossoms. Its usual height or length in ordinary cultivation, however, is only about 15 feet. It thrives best in a soil of loam and peat or of rich mould.—The bundle-flowered species, *Wistaria floribunda*—called by some botanists *Glycine floribunda*, and by others *Dolichos polystachyos*—was introduced from China in 1820, and has a creeping or trailing habit, and carries purple and white flowers, and is in some respects a handsomer plant than even Consequa's.

WITCH HAZEL. See HAMAMELIS.

WITHERINGIA. A genus of ornamental exotic plants, of the nightshade family. Seven species have been introduced to Britain, principally from South America; and nine or ten more are known. One of the introduced species is an annual, one is a tuberous-rooted perennial, three are herbaceous evergreens, and two are evergreen undershrubs. They vary in height from 6 inches to 3 feet; two have respectively blue and white flowers, and the rest have yellow flowers; most bloom from May till autumn; and nearly all love a soil of loamy peat.

WITHERS. The long upright processes of the first few dorsal vertebræ of the horse, rising above the shoulders, and often forming a considerable ridge. In consequence of their giving attachment to the elastic ligament which supports the head, their length and direction in a great measure determine the character of the horse's carriage; and in consequence of their being rendered prominent by a proper backward direction of the shoulders, they serve as a good index of the safe-going character of the horse's action. A considerable or comparatively high elevation of the withers is essential in a saddle-horse, both for preventing the displacement of the saddle, and for maintaining at a maximum the pleasantness of the animal's action.

WITH-WIND. See BINDWEED.

WITHY. The flexible shoot or bough of a willow.

WITSENIA. A genus of ornamental, evergreen, herbaceous Cape-of-Good-Hope plants, of the iris family. The corymbose species, *W. corymbosa*, was introduced to Britain in 1803; and has a height of about 6 inches, and carries pale blue flowers from April till September. The Moorish or dark-flowered species, *W. maura*, was introduced in 1790, and has a height of about 4 feet, and blooms from January till September; and, excepting in some trifling resemblance in the foliage, it differs so widely from the preceding that no person but an experienced botanist would suspect the two plants to be any way nearly related. The flowers of the Moorish proceed in pairs from imbricated sheaths at the apex of the stem; and they have a yellow limb, and a peculiarly long tube, which is green on the lower part, and gradually merges into a blackish purple at the top. The branched species, *W. ramosa*, is about a foot high, and has pale blue flowers, and blooms from April till June. All the three species love a soil of sandy peat, and are propagable from cuttings.

WOAD,—botanically *Isatis*. A genus of herbaceous plants, of the cruciferous order. The pod is flat, elliptical, one-celled, and one-seeded, and has adhesive and somewhat boat-shaped valves; the seeds are ovate-oblong; and the cotyledons are flat, incumbent, and seemingly in the same direction as the almost obliterated dessepiment of the pod should be. One species grows wild in Britain, and is at the same time an agricultural plant; about a dozen species have been introduced from other countries, principally Southern Europe and South-western Asia; and a few other species are known. All the introduced species are hardy and yellow-flowered; one is perennial-rooted, and the rest are, in about equal proportions, annuals and biennials; two have indehiscent and comparatively broad pods, girt by a broad leafy wing, and the others have subdehiscent and comparatively linear pods, with suberous margin; all are summer-bloomers, and have a height of less than 2½ feet; and some have a weedy appearance, and the rest only a half ornamental character.

The indigenous species, or dyer's woad, or woad par excellence, *Isatis tinctoria*, concentrates in itself the main interest of the genus. It occurs in a wild state in the corn-fields and field-borders of England; but is rare, and has neither the smoothness nor the luxuriance which it possesses in a cultivated state. The ancient inhabitants of the British Islands coloured themselves with a blue preparation obtained from it; and therefore those in the north were called Picts by their Ro-

man conquerors from the Latin word *pictus* signifying painted, and those in the south were called Britons from the Celtic word *britho* signifying to paint. Woad was at one time very extensively cultivated both in England and in Scotland; but, in consequence of being generally superseded for the dyer's purposes by indigo, one-thirtieth part of which yields as much colouring matter, it has in almost all districts been driven out of cultivation except in a few parts of Lincolnshire. But it is indigenous throughout most of Continental Europe, and is still cultivated to a considerable extent in Flanders and in the South of France. Its root is tapering, thick, fibrous, and branching; its stems are upright, much branched, and about 3 or 4 feet high; its radical leaves have pretty long footstalks, and are ovate-lanceolate, notched, and about a foot in length; its cauline leaves are clasping, almost entire, and about 3 inches long and ½ an inch broad; its flowers have small petals, and are of a bright yellow colour in both calyx and corolla, and bloom from May till July; and its pods stand on slender pendulous footstalks, and are nearly half an inch long and two inches wide, and have a chestnut or dark brown colour, and a shining surface. An old popular name of this plant was glastum, from the Celtic word *glas*, signifying blue; and this name gave rise to the appellation of the town Glastonbury.

The best soil for woad is rich mellow loam, containing a large proportion of vegetable mould; and it must be deep and in fine condition. The rich alluvial pastures of Lincolnshire, when newly broken up, serve excellently for woad, and at the same time are cleared by it from wire-worms so as to be rendered eminently fit for subsequent crops of grain. Arable land intended for woad, be it what it may, must be both light and fertile, in a well drained condition, and not retentive of moisture. In autumn, it should be well ploughed and ridged up; throughout winter, it should enjoy full exposure to the action of frost and wind and rain; and in spring, it should be harrowed down, ploughed across, reploughed, and reduced by subsequent tillage to a state of perfect cleanness, and fine pulverization — or, when practicable, treated in the manner of summer-fallowing up to the time of sowing. Pasture or ley land, intended for woad, must be treated according to its character and condition; and in some instances, may need vastly less preparation than land which has been under a series of tillage crops,—in others, may require to be pared and burned.—The seed is sown in the latter end of July or beginning of September, and again at intervals in the spring, from February till May, so as to vary the time for stripping the plants of their leaves. About six bushels of seed are sown on the acre broadcast, but much less in drills. As the value of the woad plants depends upon the luxuriance of their growth, and the thickness of their leaves, much attention is necessary to the after-management of the crop. In the spring-sown crops repeated hoeing should be attended to, all weeds removed, and the plants thinned out as they extend in growth, until they stand 6 or 7 inches apart, or more, according to the fertility of the soil, always leaving sufficient space to prevent their being crowded. After this nothing more is done till the first cropping of the leaves has been performed, when the plants are again well weeded; and this is repeated immediately after each operation, the extent of ground cleared in the day being weeded before night. In the late mode of sowing, after the second weeding in October, nothing further is required until April, when the mould should be well stirred about the roots, and the ground carefully weeded. This will keep the plants clean till the first crop is gathered, and then the process of weeding must be performed as before directed.—In the spring-sown crops, the leaves are generally ready for gathering from the end of June till the first week in July, according to soil and season. The gathering should be performed as soon as the leaves are fully grown, while they retain their perfect green colour, and are highly succulent; for if left until their colour turns, they are much deteriorated. The leaves are gathered into baskets made for the purpose; and the crop, if well managed, will afford two or three gatherings in the season. The portion left for seed is generally cropped of its leaves the first year, and left to run up for seed the next; but some cultivators remove the side leaves only. The plant is sometimes fed down by sheep in the winter.

In the preparation of woad for the dyer, several processes are necessary. It is first conveyed in horse-carts so contrived as to be lifted from the axle, and by folding-doors in the bottom to discharge their contents upon the floor above the mill, which is of a peculiar kind, having several wheels for grinding the plants with less diameters on one side than the other, being about three feet in width, and constructed with iron bars for crushing the woad. The materials are preserved under the grinding wheels by proper contrivances, which, as soon as they are sufficiently reduced, force it out of the tracks upon the stone floors and the sides, thus making way for new parcels without the mill being stopped. The bruised woad is then thrown into rooms by the sides of the mill destined for its reception. It there remains till the juice is so much drained off as to leave it in a proper condition to be formed into balls; which is done by labourers, with apparatus for the purpose, and then laid upon trays to be conveyed to the drying-houses. These are placed on the sides of galleries for the convenience of removal. The woad is kept in these until dry enough to be laid up in other rooms, and the whole of the crop has undergone this operation, when it is ready to be manufactured. In order to prepare it for the use of dyeing, it is necessary for it to take on a proper state of fer-

mentation, which is accomplished in the course of 7 or 8 weeks, and is called 'couching.' It is effected by regrinding the balls in the same mill as before to a fine powder, and then spreading it upon the floor of the rooms in which the balls were formed to the thickness of three feet. It is then moistened with water so as to keep it in a slow state of fermentation, which is managed by frequent turnings, and to be properly done requires practice and judgment, for the goodness of the article will depend on its being stored and dried in a proper manner. When this attention is neglected, the woad will not on being broken between the finger and thumb draw out into fine hair-like filaments, or, as the manufacturers call it, beaver well; as the use of this substance in the vat of the dyer is not only to afford the colour of the plant, but, by bringing in a very gentle fermentation, excite the indigo in the same vat to yield its colouring principle more perfectly. This is even necessary for its own colouring matter being fully imparted. The substance should, therefore, be so prepared in the different operations as to produce this effect in the most certain and perfect manner. When the heat in the process of 'couching' has gone too far, the substance will be what is called foxy; and when it has not proceeded to a sufficient degree, it is called heavy. If the material is good, it does not soil the fingers on being rubbed between them; but such as is heavy does. In the conclusion of the process, the cooling is effected in so gradual a manner as to render it not fit for taking on the same process, and, of course, proper for being preserved in casks or in any other way. It is then fit for use.

The French process of preparing this dye differs materially, and is thus described by Astruc, in his Natural History of Languedoc:—The plant puts forth at first five or six upright leaves about a foot long and six inches broad; when they hang downwards and turn yellow, they are fit for gathering; five crops are gathered in one year. The leaves are carried directly to a mill, much resembling the oil or tan mills, and ground into a smooth paste. If this process were deferred for some time, they would putrefy and send forth an insupportable stench. The paste is laid in heaps pressed close and smooth, and the black crust which forms on the outside reunited if it happens to crack; if this were neglected, little worms would be produced in the cracks, and the woad would lose part of its strength. After lying for 15 days, the heaps are opened, the crust rubbed and mixed with the inside, and the matter formed into oval balls, which are pressed close and solid in wooden moulds. These are dried upon hurdles; in the sun they turn black on the outside, in a close place yellowish, especially if the weather be rainy. The dealers in this commodity prefer the first, though, it is said, the workmen find no considerable difference between the two. The good balls are distinguished by their being weighty, of an agreeable smell, and when rubbed of a violet colour within. Those injured by wet have an earthy appearance inside and a disagreeable smell; the mouldy and rotten are light, having lost their substance. For the use of the dyer these balls require a further preparation: they are beaten with wooden mallets on a brick or stone floor into a gross powder, which is heaped up into the middle of the room to the height of four feet, a space being left for passing round the sides. The powder, moistened with water, ferments, grows hot, and throws out a thick fetid fume. It is shovelled backwards and forwards, and moistened every day for 12 days, after which it is stirred less frequently without watering, and at length made into a heap for the dyer. The French, who certainly excel us in the art of dyeing, still consume a vast deal of woad, and this may be attributed to its superior quality produced by their peculiar method of manufacturing it.

Woad has sometimes been recommended for cultivation as a forage plant; and, when so destined, is sometimes designated by its French name 'pastal.' But its value in this capacity is not great; for though it has a hardy nature, a vigorous growth, and a nutritious composition, it makes excessive demands upon both the fertility of the soil and the tillage labours of the husbandman, and refuses to yield large produce in any of the inferior or the ordinary circumstances of soil and tilth in which other forage plants, scarcely or not at all inferior to it in hardiness and bulk, are abundantly productive. Even the practice of feeding sheep in winter upon crops of it intended for the dyer is questionable; for it probably occasions more loss in the ultimate value than affords profit in the present use.

WOLD. See Dyer's Weed.

WOLDS. See Downs.

WOLFSBANE. See Aconite.

WOLVES' TEETH. Any teeth in the horse which acquire such rough or pointed surfaces as to lacerate the tongue or gums. See the article Teeth.

WOMB. See Abortion, Parturition, and Inflammation.

WOOD. Either the characteristic principle and main constituent of trees and shrubs,—and that is discussed in the article Lignin; or the hard portion of the stems and boughs of trees and shrubs, suitable for use in carpentry and turnery,—and that is discussed in the article Timber; or the chief bulk or entire substance of trees and shrubs,—and that is discussed in the articles Tree and Shrub; or any collection or assemblage of living trees and shrubs,—and that is discussed in the articles Coppice, Shrubbery, Grove, Forest, and Plantation.

Small woods on farms are common in some parts of Britain, particularly in the South of England, and are useful for hop-poles, fence-rails, hurdles, faggots, and many other objects of the

farm-field or the farmery, and also furnish ready supplies in a small way to coopers, cloggers, and other parties who can deal more facilely with a farmer than with a landowner; but they are subject to more inconveniences and liable to more mismanagement than other kinds of woods,—and have connexion with some troublesome customs or rules of tenancy which do not work well for either tenant or landlord. One thing which injures them is the ignorance which prevails among farmers on right practices of forestry, or the want of such a knowledge of the kinds and habits and adaptations of the different species of trees as is ordinarily possessed by the planters and managers of very extensive woods. If farmers had as good a knowledge of forestry as of farming, they of course would manage their woods as efficiently as their farms; but, in too many instances, they are little better qualified to have charge of a wood than an Irish bog-trotter is to conduct the business of a great farm of the mixed husbandry. Another evil is the pernicious practice of allowing cattle to feed in woods, under an idea that, after they are of a certain age, as seven years, the shoots are grown out of the way and cannot be hurt. Now though in strong thriving woods, cattle may possibly do but little harm to the underwood, after it is seven or eight years old, yet all the young plants, which either spring up spontaneously, or are artificially planted, must be liable to be cropped and kept down, and in weak decaying woods, there is always a great deal of the underwood so low as never to get out of the reach of cattle. Another evil is the want of draining such parts as are subject to excessive moisture; nothing being so prejudicial to a wood as too much wet. A fourth evil is the custom of suffering woods to grow too old before cutting; whereby the stronger shoots get leave to smother the weak ones, and eventually to kill the very stalks on which they grow. And to these evils may be added the practice of permitting the buyer to cut the wood, thereby making it his interest to destroy every sapling, and to cut the underwood as close to the stock as possible—which in old woods is highly prejudicial to the succeeding shoots—as well as the custom of not obliging the buyers to clear the woods early in the summer, so as to prevent the new shoots from being injured by their cattle, carriages, and other circumstances.—"The average time of cutting farm woodlands," says Bayldon in his Art of Valuing Rents and Tillages, "may be stated at from 8 to 12 years, and the value from £6 to £14. In some instances, the price is much higher according to the quantity and the local value of the materials grown on an acre. These woods are cut in winter and cleared by May, that damage may not happen to the tender shoots. Young plants that grow with a stem directly from the ground are called 'maiden trees,' and are in all cases the property of the landlord, and are never cut without leave, but grow for timber; and in some places the landlords pay a trifle, ½d. or 1d. per 'teller,' as they are often called, for as many young plants as may be thought fit to keep for growing timber, and which grow on a stock or stool, and are farmer's property. In other cases, a clause in the lease gives power to the landlord to reserve without any remuneration a number of young plants, not exceeding 30 on an acre, and sometimes no number is mentioned. This system of mixing timber trees and underwoods is very injudicious and hurtful; but the custom has once got hold, and must remain, like other customs, till another banish it by slow degrees. The trees cover a large space, and hurt or kill the wood below, and they spread into a large circumference of branches without a trunk or bole of length and value. The one object defeats the other; the two purposes should be separately effected, a few outside trees being always left when cutting woods, in order to keep up the view of the scenery. Trees called 'pollards' are found in many places in considerable quantities, in hedge rows, and even in woods, cut over, some 6, 8, or 10 feet high, and consequently produce a number of sapling shoots like a stool cut near the ground. The stocks or stems are the landlord's property, and the tops often called 'frith,' belong to the farmer, and are cut periodically as the underwoods. The cuttings of these woods are found to be a valuable appendage to lands on account of the scarcity of other fuel, and in many cases add much to the eligibility of the farm. Proprietors are now getting more inclined to keep the entire management of the woodlands, cutting a portion yearly for sale and accommodation for fuel; and pollards are now being cut down in many places. This plan lessens the amount of valuation. The growth of these woods since last cutting, and which is standing at the time the tenant quits a farm, is his property; he has paid rent and taxes for the land, and has got no return, and consequently must be paid for it. The value differs greatly, from the quality of soil, and the amount of produce, from 7s. to 20s. an acre for a year's growth on woodlands, and a corresponding value will be given for pollard tops by the growth since last cutting. Considerable quantities of shoots on old stools are often found in hedge rows, which will also be looked at and valued. Where the fences are much neglected and out of repair, such growth is often given for repairing them, according to the judgments of the valuers, who are usually persons living in the neighbourhood, and well-acquainted from long practice with the customs of the place, and what constitutes a fair value."—The subject of woods in the hedge-row disposition is disposed of in the article ENCLOSURE,—of woods for sheltering purposes, in the article SHELTER,—and of woods in parks and for general purposes of decoration, in the article LANDSCAPE GARDENING.

WOOD-ASHES. See ASHES.

WOODBINE. See HONEYSUCKLE.

WOOD-BORING BEETLES. See Bostrichidæ.

WOODCOCK,—scientifically *Scolopax Rusticola*. A British bird of passage, belonging to the longirostrous family of Grallæ, and constituting the type of a large portion of that family. It is a bird thoroughly known to all sportsmen; and though not classed as game, affords them to the full as much diversion as any birds which are so classed. It begins to appear in Britain about Michaelmas, and departs in March; and it is regulated, as to the precise period of its migration, more by the wind than by the moon. It arrives in flocks during the night or in a fog; and it soon becomes less gregarious, and afterwards pairs while in this country. The woodcocks which arrive first in the season are the largest, and fly heavily, and are muffled in the under parts of their head, and somewhat also in the other parts of it, with short feathers; those which arrive in November and December are rather smaller, and have smoother feathers and a shorter bill; and those which arrive about Candlemas are quicker of wing than their predecessors, and take longer flights, and are more difficult to be shot in consequence of their not rising above the spray. The weight of the woodcock, on the average, is from 12 to 14 ounces; the length is 15 inches, and the breadth 26; the bill is 3 inches long, hollowed lengthwise with deep furrows, reddish at the base, dusky towards the end, and furnished with a somewhat fleshy tip, which appears susceptible of a sort of touch for detecting its prey in the moist earth; the upper mandible hangs over the lower, and forms the round point of the bill; the tongue is slender, long, sharp, and hard at the point; the eyes are large, and situated near the top of the head; the head has a remarkable shape, being rather triangular than round; the ears are placed far forward, nearly on a line with the corners of the mouth; a black line extends from the bill to the eyes; the forehead has a reddish ash-colour; the crown of the head, the hind part of the neck, the back, the coverts of the wings, and the scapulars, are prettily barred with a ferruginous red, black, and grey, but on the head the black predominates; the under eye-lid is white; the chin is ash-colour; the fore part of the neck is yellowish, and marked with dusky minute dashes; the under parts of the body are dirty white, barred with numerous transverse dusky lines; the quill feathers are dusky, and marked on the outer web with triangular rufous spots; the tail consists of twelve feathers, dusky or black on the one web, and marked with red on the other; the tips of the tail are ash-coloured above, and white below; the shades of the plumage are so blended that the bird, as usually observed by the sportsman, exactly resembles the withered stalks and leaves of ferns, sticks, mosses, and grasses, on the back ground of the scenery by which it is sheltered; and the legs and toes are pale flesh-coloured brown,—and the latter are almost entirely divided, having only a very small web between the middle and the interior toes. The nest is placed on the ground, generally against an old stump or great root of a tree, and consists merely of a few dried fibres and leaves. The eggs amount to 4 or 5, and are larger than those of the pigeon, and have a rufous grey colour, marked with dusky blotches. The flesh is regarded by most epicures as delicious, and thought superior in flavour to that of the partridge.

WOOD EVERLASTING PEA. See Lathyrus.

WOOD EVIL. A disease in cattle somewhat similar to enteritis. It arises from browsing on the buds of trees, particularly those of the oak and the ash; it does not comprise so much intestinal inflammation, or so speedily run its course, as enteritis; it is indicated by heat of the mouth and skin, thirst, colicky pains, depression, excessive constipation, difficulty of voiding urine, hardness of the fæces, and redness and powerful odour of the urine; it continues during from 12 to 20 days, and, in bad cases, terminates in gangrene and death; and it must be treated with bleeding, purging, the application of blisters or hot water to the belly, and the restriction of the diet to gruel and mashes. The name wood evil is also given by some cow-doctors to some rheumatic complaints, and to general debility resulting from inflammatory action.

WOODLAND. Land occupied by assemblages of trees. See the articles Wood, Coppice, and Plantation.

WOODLAND. Any dark-coloured, humous, argillaceous soil of similar appearance and properties to that of old and ill-drained woods, which is kept perpetually moist by the dropping of trees, the fall and decay of leaves, the want of ventilation and sunshine, and a low and embarrassed state of evaporation. The name woodland, in this application of it, is provincial and lax, yet conveys a considerable degree of descriptive meaning. The soil designated by it retains for a long time any water which falls upon it, and in wet weather sticks firmly to the ploughshare, and in prolonged drought is very apt to crack, and, when not worked well and constantly by cultivation, commonly produces rushes and other coarse aquatic vegetation.

WOOD-LARK. See Lark.

WOODLOUSE,—scientifically *Oniscus*. A genus of minute animals, classed by some naturalists as apterous insects, and by others as isopodous crustaceans. Their body has a flattened appearance, or is broader than thick; their feet amount to fourteen, and are unguiculated, and have not any vesicular appendage at the base; and the under part of their tail is furnished with very apparent appendages resembling leaflets or vesicular bursæ. They inhabit retired and obscure places, such as fissures in walls, old buildings, cellars, and the interstices between boulders and

the ground; they seldom issue from their retreats except at night or in rainy weather; they move rather slowly, except when alarmed, but are capable of exerting some degree of nimbleness; and they feed on vegetable substances and animal matters, and are great pests in gardens. Their ova are enclosed in a pectoral pouch; and their young have only twelve feet, and have one thoracic segment less than the adults. They are known in France under the strange name of pigs of St. Anthony; and they had long an abominable reputation among some medical men, and still have it among some of the peasantry, as an internal remedy for some diseases,—being boiled in milk, and supposed to possess aperient, diuretic, and absorbent properties.

The common woodlouse, *Oniscus asellus*, is about half an inch long and a quarter of an inch broad, of an oval shape, and of a dark mouse colour. Round its outer edge are eight or nine spots of a paler colour; and its back is armed with a strong bright shell. If unable to escape quickly when touched, it usually rolls itself up in a ball, and appears lifeless, till the apparent danger is over. Its eggs are very numerous, very minute, shining, and of a very pale yellowish white colour; and they appear to be hatched in a few hours after deposition. The young have a pale colour, and though very small, begin to crawl slowly about; and in a day or two they become very active, and change to a pale reddish brown colour. When half grown, they assume the same colour as the parents, but without the markings on the back; they can then run very nimbly, and are remarkably voracious, devouring everything eatable which comes in their way; and as they advance in growth, they cast their skins, after the manner of spiders. When full grown, they become heavy and less active; and appear to require less food than during their growth. This insect is very injurious, and where very prevalent is not readily got rid of. It shuns light, particularly that of the sun; and commits its depredations during the night. It cautiously creeps from its place of retreat, and feeds on leaves, flowers, fruits, or whatever else it can find; and if not wholly destroying any plants or fruits which it attacks, it so injures and disfigures them, that they with difficulty recover.

The methods of keeping down woodlice and destroying them are many; and only some of the most obvious and of the most efficient need be mentioned. A live toad kept in a house will keep it free from them. The newt feeds on them, and might be advantageously encouraged in any garden frames which they infest. The beetle trap effectually destroys them. Boiling water poured into any crevices or cracks of walls or buildings where they are known to have their retreats, will destroy as many of them as it can reach. Loose stuffings of hay or dry moss in a flower-pot or any similar vessel, placed near their retreats, will decoy them by way of shelter; and, every morning, such as betake themselves to the vessel may be emptied out and destroyed. Longitudinal sections or halves of old bean stalks or of cabbage stalks, nine inches or so in length, laid in different parts of the house or garden which they frequent, will also entice them for shelter, and gather a collection of them for every morning's clearance. A little bit of old cheese, pulverized with a grater, spread in a vessel, sprinkled over with a little white sugar, and covered with hay or dried moss, will greatly add to the power of the decoy, and attract large assemblages of them for destruction. Slices of bryony root, apple, pear, potato, or any other succulent vegetable substance most attractive to them, put into pans or feeders, such as are generally used under strawberry pots, and covered with hay or dried moss, act as excellent decoys, and may be used to assemble the frequenters of beds, frames, and all other parts of the garden for a destructive bath in boiling water. Several methods of poisoning with arsenic are practised,—and resemble these decoy methods, with the simple difference that they kill the woodlice as well as decoy them; but they merely save the trouble of getting up some boiling water or other ready means of destruction in the mornings, and are therefore not worth the additional pains and great danger of using the arsenic.

WOODPECKER,—scientifically *Picus*. A genus of birds of the scansorial or climbing order. They are well characterised by their long straight angular bill, the end of which is compressed into a wedge, and fitted for splitting the bark of trees, —by their slender tongue, armed near the tip with spines that curve backwards, which, by the action of the elastic horns of the hyoid bone, can be thrust far out of the bill,—and by their tail, composed of ten quills with stiff and elastic stems, which acts as a prop in supporting them while they are climbing. They are very eminent climbers, wandering over trees in every direction, striking the bark off with their bills, and insinuating their long tongues into its cracks and crevices to obtain the larvæ of insects, on which they feed. This tongue, besides its armour, is constantly moistened with a viscid fluid, secreted by large salivary glands; it is drawn back into the bill by two muscles, which are wound round the trachea like ribands; and while it is in this state of retraction, the horns of the hyoid bone ascend under the skin and round the head, as far as the superior base of the bill, and the sheath of the tongue is doubled into folds in the bottom of the throat. They have an almost membranous stomach, and have no cæca, and yet they eat fruit. They are timid and wary; and pass most of their time in solitude; but during the pairing season, the males may often be heard summoning the females by loud and rapid tapping on a dry branch. The nests are built annually in holes of trees; and the eggs are brooded over alternately by the male and the female. Six or seven species in-

habit Europe; and four of these are occasionally met with in Britain.

The great black woodpecker, *Picus martius*, is the largest of the British species,—almost as large as a crow, and measures 16 inches in length; and it is all over of a uniform black colour, with a beautiful rich blood red in the calotte of the male, and a mere spot on the occiput of the female. It prefers pine forests to all other haunts.

The green woodpecker, *Picus viridis*, is the most common and the best known of the British species; and is popularly known, in different districts, by a variety of more or less descriptive names, such as rain-bird, woodwale, hew-hole, yaffil, whittle, and witmale. It occurs in all or almost all the woodland districts of both England and Scotland; and is generally seen either climbing a tree in search of its insect-food, or passing by a short, undulating, and somewhat laboured flight from one tree to another; and it usually prefers the beech and the elm to all other trees. It is one of the most beautiful largish birds in Europe. Its total length is about 13 inches; its back, its wings, and other parts of the upper surface of its body, have a dark green colour tinged with yellow; the under parts of its body are whitish; its calotte is bright scarlet; and its rump and upper tail coverts are sulphur yellow. Its young are marked with black spots beneath, and with white spots on the mantle.

The great spotted woodpecker, *Picus major*, is the next best known British species, and is somewhat common in gardens, parks, groves, and plantations, in the woodiest districts of the midland counties of England; and it is popularly called in some places the whitwall, and in others the wood-pie or the French-pie. It prefers evergreen trees, and often approaches human dwellings, but scarcely ever lights on the ground; and it feeds on larvæ, on insects, on seeds, and on ants. Its total length is 9½ inches; its occiput is bright scarlet; the top of its head is dark bluish black; its irides are red; its forehead, its ear-coverts, and a circle round each eye are dull dirty white; its throat, its neck, its breast, and its belly are dirty white; its back, the nape of its neck, its rump, and its upper tail-coverts are black; and its vent and its under tail-coverts are red.

The little spotted woodpecker, or small barred woodpecker, *Picus minor*, is not uncommon in the vicinity of London, and in the midland English counties, but has such retiring habits and is so much smaller than the other species that it readily escapes observation, and is considered comparatively rare. It is said by some naturalists to search on foot for ants,—and it has thence been called the grasspecker; but its really having such a habit is at least doubtful. Its total length is 5¾ inches; the middle of its back is white, barred transversely with black; its wing-coverts and its tail are black; its chin, its throat, and all the under surface of its body are dull white; and the crown of the head of the male is bright scarlet.

WOODRUFF,—botanically *Asperula*. A genus of ornamental herbaceous plants of the madder family. Two species grow wild in Britain, and nearly 30 have been introduced from other countries, principally the south and south-east of Europe. One of the introduced species is a hardy annual, one is a frame evergreen, one is a hardy perennial creeper, and all the others are hardy, annual-stemmed, erect perennials. They vary in height from one or two inches to upwards of two feet, but most have a height of between 6 and 15 inches. Their flowers are either white, flesh-coloured, pink, red, purple, lilac, or yellow; and, in most instances, bloom in June and July. Most of the species are very handsome, and possess the agreeable habit of flourishing under the shade of trees, and thrive in any common or even somewhat moist soil.

The small woodruff or squinancy-wort, *Asperula cynanchica*, is a native of the chalk hills of England. The root is perennial; the stems are numerous, ascending, profusely clothed with whorled foliage, and from 4 to 10 inches high; the leaves are linear, smooth, and four in a whorl,—and the upper ones are very unequal; and the flowers grow in terminal panicled tufts, and have a whitish or flesh colour, and are sometimes very fragrant, and bloom in July. This plant was formerly regarded as, in both external and internal use, a remedy for quinsey or squinancy,—and it thence derived both its popular and its botanical names; but it was utterly undeserving of any such reputation. An infusion of it, however, is astringent, and might serve as a gargle.

The common or sweet woodruff, *Asperula odorata*, is a native of the dry woods of many parts of Britain. The root is perennial and creeping; the stems are simple, clothed with whorled foliage, and from 4 to 10 inches high; the leaves are lanceolate, spreading, bright green, about an inch long, and eight in a whorl; the floral panicles stand on longish footstalks, and generally grow three together; the flowers have a short tube and a pure white colour, and bloom in May and June, and are fragrant chiefly at night; and the fruit are small capsules so armed with ascending bristles as to feel quite rough. This plant, when cut and laid out to dry, emits a strong and delightful fragrance similar to that of *Anthoxanthum odoratum*, bitter almonds, and heliotrope; and it continues to give out some of this fragrance during a considerable time after it is quite dry; and it has, in consequence, been much used for scenting clothes, flavouring wine, and similar purposes. The herbage, in a green state, is eaten by goats, sheep, and cattle, and is believed to have the property of increasing the secretion of milk. The edges of its leaves stick to the hands and garments by means of the minute hooked bristles which constitute their roughness; and they possess this property in common with many other plants of the rubiaceous order.

The dyer's woodruff, *Asperula tinctoria*, is a native of the South of Europe, and was introduced to Britain in 1764. Its root is perennial; its stems are reclining, and about 9 or 12 inches long; its lower whorls of foliage are six-leaved, its middle ones four-leaved, and its upper ones two-leaved; its leaves are linear and three-nerved; and its flowers are trifid, smooth, and whitish, and bloom in June and July. The roots are used in Dalmatia and some other countries for dyeing wool and cloth of a reddish colour; but they are not better than madder, and do not produce so large a crop.

WOOD-RUSH. The indigenous junceous plants of the genus luzula. See the article RUSH.

WOODSIA. A small genus of very handsome ferns of the polypody tribe. The Ilva or oblong species, *W. ilvensis*, occurs wild in many parts of Britain, and has a height of about 6 inches; and blooms in June and July; and the northern species, *W. hyperborea*, inhabits some of the lofty rocky mountains of Scotland, and has a height of about 3 or 4 inches, and blooms from July till September. Both species have fibrous roots, and stalked, erect, tufted, pinnate and pinnatifid fronds, clothed with simple hairs or with narrow pointed scales; and they thrive best in a mixture of peat and loam, and may be propagated either from seed or by radical division.

WOOD-SORREL,—botanically *Oxalis*. A large and diversified genus of thalamiflorous plants, constituting the type and the main part of the natural order Oxalideæ.—This order has a near botanical affinity to the rue, the zygophyllum, and the balsam families, and it is distinguished principally by the peculiar habit of its plants, and it comprises within the gardens of Britain, species belonging to the genera oxalis, biophatum, and averrhoa. — The wood-sorrel genus has a calyx of five segments, either quite distinct or united at the base,—a corolla of five petals, ten stamens, and five pistils, with the five exterior stamens shorter than the five interior ones,—and a seed-vessel of an oblong or cylindrical form. It is a genus of considerable utility and of very great beauty, and begins to challenge the serious attention of the farmer, and has long engaged much care and admiration from the gardener and the florist. Two species grow wild in Britain; about 120 have been introduced from other countries, principally the Cape of Good Hope and South America; and a great many more are known. A few of the introduced species are annuals; a few are fibrous-rooted evergreen herbs; three or four are evergreen undershrubs; and most of the remainder are bulbous-rooted herbs. Several are cultivated for culinary and economical purposes; and all possess more or less elegance in the flower garden. The roots of some and the leaves of several are esculent; and almost all have more or less of a very agreeable acidity, which depends on the presence of a small quantity of oxalate of potash,—and a few of the tropical ones possess this property in so eminent a degree as to contain a comparatively large quantity of oxalic acid. A few are hardy; a few require the stove; and the vast majority are suited to the greenhouse. The largest of ten groups or divisions of the genus—so large in fact as to comprise about one-third of all the species—takes the common British sorrel as its type, and has no stems, petiolate trifoliate leaves, and one-flowered scapes; another and much smaller tribe takes the other indigenous sorrel as its type, and has leafy stems, palmate-trifoliate leaves, sessile leaflets, and one, two, or many-flowered scapes; a third has elongated leafy stems, trifoliate sessile leaves, and axillary one-flowered scapes; a fourth has elongated sparce-leaved stems, stalked and from three to five leafleted leaves, and axillary one-flowered scapes; a fifth has no stems, stalked and from three to many leafleted leaves, and one, two, or many-flowered scapes; a sixth has no stems, simple leaves, and one or many-flowered scapes; a seventh has no stems, winged petioles, bifoliate or trifoliate leaves, and one-flowered scapes; an eighth has leafy stems, petiolate and from three to five leafleted leaves, and leafy stems; a ninth has no stems, palmate and peltate petioles, from five to thirteen leafleted leaves, and one-flowered scapes; and the tenth has leafy stems, trifoliate leaves with the middle foliole petiolate, and many-flowered scapes.

The little sorrel, or common wood-sorrel, *Oxalis acetosella*, grows wild in woods, under hedges, and in other shaded situations in many parts of Britain. Its root is squamosely bulbous, horizontal, toothed, fleshy, and of a reddish colour; its leaves are radical, petiolate, and ternate like those of trefoil; its leaflets are obcordate, quite entire, hairy, of a yellowish green colour above, and purplish underneath; its scapes are radical and single-flowered; its flowers are bell-shaped, drooping, either white or purplish, and always streaked with fine branching purple veins, and bloom in April and May; its capsules are membranous and two-sided; and its seeds are invested with a white, fleshy, dehiscent tegument. This plant is inodorous, and has a strong, pleasant, acidulous taste, and makes a refreshing and wholesome conserve with fine sugar. It is an object of great beauty, and seems to have been the true or original shamrock of Ireland. See the article SHAMROCK. The expressed juice of it reddens vegetable blues, coagulates milk, and precipitates lime from solution. The plant is a very agreeable and wholesome salad; and possesses refrigerant, antiseptic, and antiscorbutic properties; and when boiled in milk gives off its acidulousness to the whey;—and either this whey or the expressed juice of the plant, much diluted with water, may be used as a good refrigerant drink in fevers. The plant thrives in any common soil, and is easily propagated from offsets; and these should be planted in a shady border.

The small horned or yellow procumbent wood-

OXALIS CRISTATA

ART. WOOD SORRELL. Vol. 4.

PSOPHOCARPUS TETRAGONOLOBUS

ART. DOLICHOS. Vol. 2. Page 42.

OXALIS DEPPII

ART. WOOD SORRELL. Vol. 4.

Engd by G.H. Swanston Edinr

A. Fullarton & Co. London & Edinburgh.

sorrel, *Oxalis corniculata*, grows wild in shady, moist, rocky or waste grounds in many parts of Britain, and has become almost a weed in some gardens. Its root is annual and fibrous; its stems are procumbent, branched, leafy, and about 3 inches high; its leaves are palmately trifoliate, and have sessile leaflets; and its flowers grow in small umbels on footstalks, and have a yellow colour, and bloom from May till October.

The crenate-flowered, notch-petalled, tuberous-rooted, or potato-bulbed wood-sorrel, *Oxalis crenata*, is a native of Peru, and was introduced to Britain in 1829, and has for several years been claiming the attention of farmers as possibly a valuable agricultural plant. A coloured figure of it is given in *Plate LXIV.* Its roots are tuberous and esculent, and are used in the same way as the tubers of the potato; its stems are succulent, branching, and about 3 feet long, and they bend over or trail on the ground, but are upright toward the point of the shoots; its leaves are trifoliate and slightly hairy, and have inversely heart-shaped leaflets; and its flowers have bright yellow petals, with crenate or notched edges, and bloom in September. The average weight of each tuber, in experimental growths of the plant at Ayton House in Berwickshire, was two ounces; and the average aggregate weight of all the tubers at each plant, in experimental growths at Meadowbank Nursery near Edinburgh, was half a pound. The foliage and the tender juicy stems of the plant, as well as the tubers, are esculent, but are used in the way of salad; and it is cultivated in its native country for the sake of both them and the tubers. It thrives best in dry light soils of medium fertility, and requires a warm and well sheltered situation, and should be planted at distances of between 2 and 3 feet. The tubers do not begin to form till toward the end of autumn; and, when cooked, they have a yellowish colour, a very mealy consistency, and a taste slightly and pleasantly acidulous, but in other respects similar to that of a fine potato. The presumption is that, bulk for bulk, they are much more nutritious than potatoes, and that, at the same time, they possess decided antiscorbutic and antiseptic properties, so as to be greatly more wholesome than potatoes for use along with a flesh-meat diet.

Deppe's wood-sorrel, *Oxalis Deppei*, is a native of Mexico, and was introduced to Britain in 1827. It possesses similar agricultural recommendations to the preceding, and is also figured in *Plate LXIV.* But it is a much smaller plant than the crenate-flowered wood-sorrel, and has very beautiful coppery-red flowers, and blooms throughout the long period from March till November, and thrives best in a soil of sandy peat.

The four-leaved wood-sorrel, *Oxalis tetraphylla*, is also a native of Mexico, and was introduced to Britain in 1823. Its roots are thick and fusiform, and send up many spreading filaments from the crown, with attached small scaly bulbs, which produce new plants in the following year; its leaves are radical and quadrifoliate, and have inversely heart-shaped leaflets; and its flowers come out either solitarily or four together, on an upright footstalk of about 6 inches in height, and have a light purple colour, and bloom in June and July. The leaves of this plant, like those of the common and the crenate-flowered species, are eaten in the way of salad; and both the bulbs and the fleshy fusiform roots are eaten in a cooked state.

A few of the best known or most interesting of the many ornamental species of wood-sorrel, are the small convex, *O. convexula*, bulbous-rooted, stemless, trifoliate-leaved, about 6 inches high, carrying pink flowers from January till November, and introduced from the Cape of Good Hope in 1789; the pretty, *O. pulchella*, similar in root and leaf and habit to the preceding, about 3 inches high, carrying white flowers in October and November, and introduced from the Cape of Good Hope in 1795; Piotta's, *O. Piottæ*, similar in root and leaf and habit to the two preceding, about 3 inches high, carrying orange-coloured flowers from January till September, and introduced from the Cape of Good Hope in 1816; the various-coloured, *O. versicolor*, bulbous-rooted, leafy-stemmed, glandularly and linearly leafleted, about 3 inches high, carrying crimson flowers from January till March, and introduced from the Cape of Good Hope in 1774; the yellow, *O. flava*, bulbous-rooted, stemless, petiolately, palmately, and numerously leafleted, about 6 inches high, carrying yellow flowers in March and April, and introduced from the Cape of Good Hope in 1775; the cloven-leaved, *O. bifida*, tuberous-rooted, stemless, trifoliate, about 9 inches high, carrying violet-coloured flowers in September and October, and introduced from the Cape of Good Hope in 1791; the beaked, *O. rostrata*, bulbous-rooted, stemless, simple-leaved, about 3 inches high, carrying purple and violet flowers in October and November, and introduced from the Cape of Good Hope in 1795; the goat's foot, *O. caprina*, noticed in the article Goat's Foot; the flesh-coloured, *O. incarnata*, bulbous-rooted, with elongated sparcely-leaved stems, stalked leaflets, and axillary peduncles, about 6 inches high, carrying flesh-coloured flowers from April till June, and introduced from the Cape of Good Hope in 1839; the rosy, *O. rosea*, fibrous-rooted, leafy-stemmed, evergreen palmate trifoliate leaved, about 6 inches high, carrying red flowers in March and April, and introduced from Chili in 1823; and Barrelier's, *O. Barrelieri*, an evergreen undershrub, with leafy stems and trifoliate leaves, about 18 inches high, carrying pale red flowers throughout most of the year, and introduced from Caraccas in 1824.

WOOL. The filamentous substance which constitutes the peculiar natural covering of sheep. It resembles hair at once in physiological charac-

ter, in chemical composition, and in natural uses; but differs from it in texture, in form, in softness, unctuousness, and pliability, and in adaptation to artificial purposes. See the article Hair. It grows from a soft pulp included in a bulb-like sac, which communicates through minute nerves and blood-vessels with the surrounding tissue; it springs from the cellular tissue, immediately below the true skin; it passes up thence to the exterior of the epidermis in the form of a fine cylinder; and, in all its development externally from the skin, it has a scaly texture with the lamina pointing from the root toward the tip, and extends in a spiral direction or with wavy curvatures, and has minute and regular serratures along its edges, and is protected and rendered soft and supple and pliant by a peculiar secretion called its yolk.

All wool is complete in its formation at the point where it issues from the skin; and receives constant accessions to its length at its radical extremity, or at the point where it issues from the bulb-like sacs. Some persons think that the lengthening of it occurs at the top, and is effected by a sort of pushing outward or upward in a manner analogous to the growth of acrogenous plants; but they may easily convince themselves of their error by staining a portion of growing wool with a solution of lunar caustic at an equal distance from the root and from the top,—for in the course of a month or so, they will readily perceive the distance between the mark and the root to have increased, while that between the mark and the top remains the same. All intelligent shepherds and store-farmers, too, know well that the white unstained wool which grows between the time of salving and the time of shearing, and which many of them familiarly call 'the rise,' is found, never at the top, but always at the root. The degree of increase is greater at some seasons of the year than at others, and differs widely at every season in different breeds of sheep; yet is powerfully controlled, in every instance, by the condition of the animal's health, the nature and quantity of its food, and the circumstances of its situation, insomuch that, under successive and wide differences of health and feeding in one year, the parts of the wool of each filament or of the whole fleece, when examined by the microscope, will be found to possess corresponding differences of character. The increase of the wool of any salved or mountain sheep, from the time of salving about the middle of November till the time of shearing about the middle of July, may readily be ascertained by measuring 'the rise,' and, in the case of a black-faced sheep of average character, pastured on a farm of medium quality, will be found about two inches; and if it be examined and measured at successive and regular intervals between the two periods, it will be ascertained to have effected one half of all its increment during the two months immediately before the shearing, or to have been proportionally double in each of the months of summer of what it was in each of the months of winter and spring. But this difference largely accrues from the comparative scarcity and plenty of food; and in the degree of its doing so, is accompanied with a corresponding difference in the quality of the successive parts or increments of the staple. Whatever wool is produced partly under full feeding and partly under deficient feeding does not exhibit an uniform glistening appearance, but is comparatively opaque in the portions which grew during the deficient feeding, and seems shrivelled and contracted, and is very liable to break, and, in consequence, is not only of deteriorated market value, but wants due fitness for many of the manufacturing purposes to which it might otherwise be applied.

The aggregate character of wool is mightily modified, and even may be totally altered, by the influences of climate, of the long continuance or violent changes of particular depasturement or feeding, and of the steady pliance of cross-breeding, peculiar farm-feeding, special shelter, and other home practices for forming or altering varieties and breeds of sheep. The covering of the wilder races, particularly in tropical or subtropical countries, comprises scarcely any wool at all, but consists almost wholly of hair, similar to that of goats; and even the covering of many of the domesticated breeds, in the more temperate regions of the world, particularly in places where defective or unskilful attention has been given to the arts of culture, contains a greater or less intermixture of real hair. But by frequent shearing, combined with the constant influence of judicious domestication, the fleece of very hairy breeds gradually parts with its hairiness and acquires more and more true wooliness, till it eventually becomes all over a tissue of genuine wool; and in the most favourable circumstances of climate and situation and treatment, it may even attain properties of comparatively high fineness, softness, and tenuity. In Britain, however, the improveableness of the fleece is much limited by the severity of our winters, the many, great, and sudden vicissitudes of our weather, and the natural limitation or embarrassment of some of our strongest appliances of domestication. Hair without any mixture of wool, indeed, covers only the face and part of the limbs of any of our sheep; yet real hair, in very many cases, is more or less mixed with the wool in the other parts of the body; and the wool itself, even when free from intermixture, continues stubbornly averse to assume as high a fineness as that of the best breeds in some other countries. Most attempts to improve the quality of our fleeces, too, have been accompanied with diminution of the quantity; and some of them have been carried so far as not only to reduce very seriously the weight of the clip, but also to affect severely the appearance and the value of

the flocks, and to render them so ill-clad as to be unable to withstand the storms of winter. The eye of patriotic poetry, indeed, may see in British sheep-walks loftier beauty and more glorious amenities than a farmer's eye can discern in those of even the richest wool countries of the world; and John Dyer, the author of a poem called "The Fleece," published in 1757, accordingly sung,—

> Our spacious airy downs and gentle hills,
> With grass and thyme o'erspread, and clover wild,
> Where smiling Phœbus tempers every breeze,
> The fairest flocks rejoice.
> —— No fleeces wave in torrid climes,
> Which verdure boast of trees and shrubs alone—
> Shrubs aromatic, coffee wild, or tea,
> Nutmegs, or cinnamon, or fiery clove,
> Unapt to feed the fleece. The food of wool
> Is grass or herbage soft, that ever blooms
> In temperate air, in the delicious downs
> Of Albion, on the banks of all her streams.

But, however rich and grateful may be the herbage of our dry and improved pastures, the prevailing dampness of our climate, as well as its occasional rigours and its many and violent changes, is an insuperable hindrance to the production of fine wool. Our system of management, also, can never have reference to any higher qualities of wool than the second-rate, and must always bear with main force upon the properties of the mutton. Even our driest pastures, the chalky downs of the South of England, give a roughness to the wool of our very best breeds; and our indispensable practice of aiding the pastures, and sometimes superseding them, with turnips and other succulent articles of diet, is fatal to all fineness of fleece. Dry pastures in a dry climate, aided when necessary by supplies of straw and other dry food, are essential to the production of prime or even excellent wool,—and constitute the secret of all the success of the wool-growers of Australia and Spain and Germany,—and are things which cannot possibly be attained, in sufficient amplitude and power, in Britain. The usages of our population, too, particularly in its paramount demand for abundance of good mutton, and in its contentment to derive all the main material for the finest kinds of woollen manufacture from other countries, compel our farmers, out of due regard to their own interest, to pay far more attention to the carcase than to the fleece; and exactly the influences of almost every kind which are most favourable for producing bulk and excellence of mutton are correspondingly unfavourable for producing good wool.

The clothing of sheep in Britain and in all similar latitudes is naturally renewed once every year,—the heavy old fleece falling gradually off in the early part of the warm season, and the light new one gradually rising beneath it and displacing it; and the annual shearing of sheep, practised by all British store-farmers, is simply the anticipating and the regularizing of the natural process. Wool, like hair, might be shorn at any time and often, and would always grow again after each cutting; but, according to universal experience, as well as on principles of obvious deduction from the character of our seasons, it cannot be economically shorn in Britain oftener than once a-year, or at any other time than about the commencement of the hottest part of summer. The shearing of lambs is quite unsuited to such a cold climate as ours, and is practised only in the most genial situations in a few of our warmest districts; and the great bulk of the lambs' wool used by our manufacturers is either obtained from the skins of lambs killed by the butcher, or imported from other countries. The greater portion of our home-grown wool, or that which is taken from the bodies of living sheep, is prepared for the market by the processes described in our articles Shearing of Sheep and Fleece; and the lesser portion, or that which is obtained from the skins of slaughtered sheep, is prepared by the fellmonger, simultaneously with the preparation of the hides, in a process which is described as follows by Mr. Southey:—"The first operation is to place the skins, one by one, on a flat stone, and to beat the parts round the head with a wooden mallet, for the purpose of loosening any clots or tufts of coagulated blood adhering to them. The skins thus prepared are then thrown into a vat of water to soak, in order to soften any substance or concretion which might attach to the wool. After remaining immersed from ten to twelve hours, the operation of washing commences by the following method:—This process is accompanied by beating the skin with a pole while in the water, which is done for the purpose of removing any dirt which the wool may still retain, it being desirable that it should be made as free from impurities as possible. When this operation is concluded, the skins are placed one upon another, to the number of twenty or thirty, for the purpose of draining; and when this is accomplished, they are laid one by one on a table, with the flesh or pelt side uppermost, when a strong solution of lime and water should be applied to the fleshy side of the skin. The brush used on such occasions is similar to the one which whitewashers work with in colouring rooms; and when thus properly smeared over by one person, another should be in attendance to fold the skins, one by one, taking care that the pelt sides are placed inwards; and so soon as this is done, they are put on poles and laid about six deep, one above another. This mode is adopted for the purpose of causing the skins to heat, preparatory to the wool being pulled, as the process operates in such a manner as to open or loosen the pores of the skin, by which means the wool is more readily drawn from it. The day after the skins have undergone the operation of liming and washing, they are taken down from the pole to shake off any water from

the extremity or points of the wool, which, if suffered to remain, would tend to discolour it. The skins, however, remain on the poles until the pores are partially relaxed, which may be ascertained by trying to separate the wool from the skin, as it will leave the pelt when in a proper state of preparation. The skins are then placed in an enclosed shed or warehouse, from which the air is excluded, and each skin suspended by the nostril or nose to afford greater facility in the operation of pulling. Before this commences, a lad is usually employed to cut off the pitch or any hard substance that may adhere to the skin, taking care not to shorten the wool. Previous to the operation of pulling being commenced, the skins should be inspected and assorted somewhat after the following method:—Those which are found deteriorated with kemp, or dead hairs intermixed with the wool, or marked with party colours, should be laid aside by themselves and kept separate from those which are entirely white. It would, in fact, be advisable, where the skins are numerous, to separate those which produce long wool from others of a shorter growth, as each class of wool is by the manufacturer applied to different purposes. There are very few party-coloured sheep in English flocks, and not many interspersed with dead or kemp and black hairs. When any perchance do appear, they should be separated from the rest, and their wool kept distinct, any intermixture being extremely detrimental to the consumer, who carefully avoids buying objectionable wool, except at low prices; and to this minute attention should be paid by all those who aim at producing skin wool of an approved quality. The coarse hairy parts about the legs should in like manner be first withdrawn and thrown aside, being entirely useless to the English manufacturer and injurious to his interest. When the skins have been properly limed and folded, in the course of two or three days, when the weather is warm, they are generally in a fit state to be pulled, which being done, the wool should be placed in a loft or open warehouse, and exposed to a free current of air to dry and become fit for packing, as otherwise it might be discoloured by heat, or even ignited. During a wet season, or in the winter months, the skinner usually has recourse to an enclosed warehouse, heated by iron pipes raised perpendicularly from the floor, in which a large fire is made of coke. These pipes are passed through the several floors where wool is exposed for drying; and at periods when the sun does not afford sufficient warmth to the atmosphere, it is customary to place the skins in an artificial heat of this kind, which proves a substitute for the sun's rays, and prepares the skin for the process of being pulled. The English fellmonger draws out the wool from the pelt by hand, the men placing the skins before them on an inclined board, but has occasionally recourse to the aid of an implement called a pulling-knife, which the operator uses in order to assist him in removing the wool from those parts of the skin which have not been sufficiently decomposed, owing to their not being so equally saturated as the rest. The skins, after being divested of their wool, are usually placed in a pit or vat filled with lime-water of a moderate degree of strength, compared with that usually applied to skins with the wool attached to them. There they remain two or three days, for the purpose of extracting any portion of the grease usually found attached to the pelt. Thence they are removed by long iron tongs to a stronger solution of lime-water, and daily drawn up and exposed to the air for several hours during the day, but out of the sun's rays in hot weather. They are then again thrown into the prepared liquid, care being taken to stir up the water previous to their immersion. In this state they continue three or four weeks, or are disposed of in the intermediate time to leathersellers, parchment-makers, or glue-manufacturers, according to their various sizes and condition."

The wool of the different races, families, and breeds of domesticated sheep differs so widely in comparative length of staple as to have occasioned them to be classified into short-woolled, middle-woolled, and long-woolled,—and differs also so widely in comparative softness and tenuity as to have caused them to be classified into coarse-woolled, medium-woolled, and fine-woolled. See the article SHEEP. But the wool of any one breed differs both in length and in fineness, as well as in other properties, according to the circumstances of climate and pasture and treatment in which the breed is reared and maintained; and the wool of each individual of every breed, in all circumstances, has somewhat widely different properties in different parts of the body. The wool of the most steady climate, the most congenial pastures, and the most judicious management, is always bulkier and finer than that of inclement districts, irregular feeding, and bad store husbandry; the wool of light arenaceous or calcareous sheep-walks has always a cleaner texture and a purer colour than that of such soils as those of some parts of Gloucestershire, which impart to it an orange tinge, or that of such soils as those of some parts of Hertfordshire and Warwickshire, which give it a brownish hue, or that of such districts as the fens of Lincolnshire and Cambridgeshire, which give it a dark blue tint; and the wool of the shoulders, back, and sides of any individual sheep, is finer than that of the upper part of the thighs, the upper part of the legs, and the parts extending thence toward nearly the haunch and the tail,—and the wool of these parts, again, is finer than that of the upper part of the neck, the throat, the breast, the belly, and the lower part of the legs. The separating and assorting of the different qualities, whether from one fleece or from a collection of fleeces, is a nice process of art, and is performed

sometimes under the direction of the manufacturers who have purchased and are about to use the wool, but more commonly by a class of persons called wool-staplers, who have qualified for their employment by a regular apprenticeship, and who purchase the raw material from the grower, and sell it in an assorted state to the manufacturer. The operator unrols the fleece on a table, spreads it out full under a clear light, and, under the joint guidance of his sight and his touch, culls out successive locks of uniform fineness of filament, and deposits them in a basket; and he assorts the whole into six or ten or, in some cases, a greater number of kinds, and has beside him a separate basket for each kind, and goes through the whole process with a promptitude, accuracy, and celerity which quite astonish the uninitiated. "In sorting wools," says M'Culloch, "there are frequently eight or ten different species in a single fleece; and if the best wool of one fleece be not equal to the finest sort, it is thrown to a second, third, or fourth, or to a still lower sort, of an equal degree of fineness with it. The best English short native fleeces, such as the fine Norfolk and Southdown, are generally divided by the wool-sorter into the following sorts, all varying in fineness from each other,—viz., first, prime,—second, choice,—third, super,—fourth, head,—fifth, downrights,—sixth, seconds,—seventh, fine abb,—eighth, coarse abb,—ninth, livery,—and tenth, short-coarse or brack wool." But either these divisions, or any others to a lesser or greater amount, would be far better designated by simple numerical names; and all vary in their relative market value, according to the demand for respectively coarse, middle, and fine cloths. The long wools, in an aggregate view, have a staple of seven inches and upwards,—the middle wools, of from four to seven inches,—and the short wools, of from two to four inches.

The comparative properties of wool are very vaguely expressed by the epithets coarse and fine, or by any other two or three general words; and they have been somewhat better designated as follows, by Arthur Young, in the order in which they are esteemed and preferred by the manufacturer:—"First, fineness with close ground, that is, thick-matted ground; second, fineness; third, straight-haired, when broken by drawing; fourth, elasticity, rising after compression in the hand; fifth, staple not too long; sixth, colour; seventh, what coarse is in it to be very coarse; eighth, tenacity; ninth, not much pitch mark, but this is no other disadvantage than the loss of weight in scouring. The bad or disagreeable properties are,—thin, grounded, toppy, curly haired, and, if in a sorted state, little that is very fine, a tender staple, no elasticity, many dead-white hairs, very yolky. Those who buy wool for combing and other light goods that do not want milling, wish to find length of staple, fineness of hair, whiteness, tenacity, firmness, elasticity, and not too many pitch-marks." Another, clearer, and shorter classification of properties may be made into soundness, length, cleanness, colour, softness, and feltability. Soundness arises from the healthy condition and proper feeding of the animal, and comprises uniformity, flexibility, and kindliness of the pile, but perfectly comports with wide diversity of the other properties correspondent to the different families and breeds of sheep. Length or shortness or any medium between the two must be variously suitable according to the different purposes of the manufacturer, but ought always to be uniform in the same specimen, or at least as nearly so as will comport with a due regard to the assortment of the other properties. Cleanness, though mainly desirable for preventing expense and loss in the process of scouring, is desirable also for its appreciable conservation of soundness and softness; and it requires that no dirty or discolouring ingredient be employed in salving, that as little as possible of any ochreous substance should ever get into the shepherd's or store-master's possession, and that the living flock, as well as the separated fleece, should be kept aloof from whatever might pollute them. Colour is important because wool excels cotton and linen and even silk in taking on bright and beautiful hues in the process of dyeing,—and because white wool receives the colouring matter more readily than black, and clear white wool more readily than creamy-coloured or brownish or dingy,—and because any mixture of black filaments with the white mars the harmony of the dye, and renders the whole specimen unsuitable for the reception of the brighter and more delicate hues. Softness has been raised to paramount importance by the demands of fashion; and depends partly on the minuteness of the fibres, partly on the combination of soundness and feltability, and partly on the abundance and tenuity of the lubricating yolk; and it more or less comprises or includes the two properties which Arthur Young and many other popular nomenclators call fineness and elasticity. What we have designated feltability is the most curious of all the properties; and is identical to a certain extent with what is popularly called fineness, but still more so with a peculiar and very beautiful structure of the filaments quite recently discovered; and may be well understood from the following account of it by Mr. Spooner:—"The felting property and other qualities of different wools have long been made known by practical experience; but we are indebted to Mr. Youatt for the discovery, that the felting property depended in a great measure on the number of serrations on its surface. This gentleman, after several laborious attempts, at length succeeded, with the assistance of a powerful achromatic microscope and its scientific maker, in developing the singular structure of wool and the difference between wools of different qualities. Each fibre was found to consist of a number of leaves attached to a central stem or band,

and extending in one direction, viz., from the root to the point. This was the result of examining a filament on an opaque object; but when viewed as a transparent object, the edges of the leaves were more visibly apparent, appearing like so many teeth pointing in one direction, and thence properly termed the serrated edge. The fibre of wool thus magnified appears somewhat like the common fir-apple. On examining different wools, Mr. Youatt found that the number of serrations corresponded to the felting qualities of the wool, being in the Saxony no less than 2,720 in the inch, in the Southdown 2,080, and in the Leicester 1,860 alone. Thus fine wool differs from coarse in having a greater number of serrations and growing in a more spiral form, which, of course, increases the number of curves; but to this we must add the fact of its being actually finer or smaller in its fibres; so that while a fibre of the coarsest wool is $\frac{1}{450}$, the finest is $\frac{1}{1500}$ of an inch in diameter. It can easily be conceived how this curious structure of the wool, particularly its serrated edge, must conduce to its felting property. As long as the filaments are kept in the same direction, these serrations are comparatively inoperative; but torn to pieces by the card and mixed in every direction, the serrated edges must tend to hook and entwine together; and this must be pretty much in proportion to the number of serrations in a given space, particularly when this is added to the fact that the wool is more curved as the serrations are numerous."

Wool is prepared for the spinner, either by the process of combing, to suit it for worsted yarn and worsted stuffs, or by the process of carding, to suit it for woollen yarn and woollen cloths. Combing divides the wool by means of fine steel teeth, and requires the comb to be kept hot and the wool to be oiled; and it frees the wool from all knots and entanglements, renders it smooth and flowing, brings out its softness and elasticity to their maximum, and arranges its filaments in parallel order or side by side, somewhat in the manner in which the fibres of flax and hemp are assorted for spinning. Worsted yarn, formed by the outdrawing and the twisting of combed wool, is of every degree of fineness, from a thickness suitable for the coarsest substances to a thinness suitable for the most delicate stuffs; and, in rare instances, it has been attenuated to the almost incredible rate of upwards of 90 miles of thread from one pound of wool,—and in the case of ordinary superfine spinning is currently drawn out to the rate of about $22\frac{1}{4}$ miles from the pound. Carding is a widely different process from combing; it breaks and divides the wool into a multitude of fragments, which, from the spiral growth of the filaments, necessarily lie together in a curved state; and it co-operates with the serratured structure of the filaments, or the feltability of the wool, to dispose all the fragments to lock together and effect the most thorough coherence on being subjected to moisture and pressure. Carded wool, by means of the due and varied appliance of mere moisture and pressure, is made into hats, beavers, caps, and numerous kinds of carpets, blankets, mantles, and cloths; and when it is first oiled, and then spun and woven, and then fullered, it serves as the material of all the dense and fine kinds of woollen cloth; and in this latter case, it is oiled in order to arrest its felting tendencies from going into action before the spinning and the weaving are effected,—and is afterwards fullered, by means of aluminous matter or clayey earth, for the double purpose of discharging the oil and of bringing its felting coherences into sudden and complete play.

"While the facility of felting is an important property in the case of all wool designed for the manufacture of cloth, and prepared by the card, it is not required in the case of wool intended for worsted, and prepared by the comb. Certain kinds of wool have this property in a higher degree than others, and are consequently better adapted for the making of woollen cloth. In general, the shorter kinds of wool having also fine filaments, are those of which the laminæ are most numerous and distinct, and are those accordingly in which the felting property is the greatest. The property, however, is not in proportion to the tenuity of the fibres, since certain short and slender wools possess it in an inferior degree. Of all known wools, that derived from the Merino race possesses the felting property in the greatest perfection, and is accordingly the best adapted of all others for the making of cloth; while the long and tough wool of the larger sheep is imperfectly adapted to the preparation of woollen yarn, and accordingly is never prepared by the action of the card. It is, therefore, the short and felting wools which alone are fitted for this process; and until a period comparatively recent, they were, with few exceptions in this country, never prepared by any other means. This gave rise to a popular distinction, long in use, and not yet entirely abandoned. The long wools were termed combing wools; the short, carding wools. But these designations are no longer applicable. By improvements in the woollen manufacture, the means have been found to prepare the shorter and more delicate wools by the comb as well as by the card; and now a great proportion of all the short wool of this country is converted into worsted yarn. The Southdown wool, which was formerly, and until a recent period exclusively, prepared by the card, is now in a still larger degree prepared by the comb for the manufacture of worsted. It has fallen in price, indeed, from its being no longer used for the finer cloths; but the range of its utility has been greatly extended. Thus it is also with the wool of the Cheviot, the Norfolk, and other short-woolled breeds; and there cannot be a doubt that, although individual interests may have been injuriously affected by the fall in the price, the

nation has been benefited by an extension of the purposes to which this class of wools can be applied. Nay, the general good of the wool-growers themselves has been eminently served. The demand for their commodity has become more steady, and the trade been placed on a surer basis, by being founded on an enlarged demand, and supported, not by artificial regulations and fiscal restraints, but by an extension of the woollen manufacture. Soon after the peace of 1814, alarm was raised among the British wool-growers lest the price of the raw material should be reduced below what they chose to term a remunerating price. The government of the day, in an evil hour, yielded to the influence exerted; and in the year 1819, heavy duties were imposed on foreign wool, with the design of keeping up the price of the native produce, under the specious pretext of encouraging British agriculture. In six years, this monstrous law was repealed, but not until it had done all that the shortness of the time allowed for establishing the manufactures of foreign rivals, and giving them the ascendancy in the markets of Europe. But the price of short wool continuing to decline, renewed efforts were made by the wool-growers to induce the legislature to restore the former restrictions. This, in 1828, led to a parliamentary inquiry, when a mass of evidence was produced, proving beyond all cavil the danger and evil of interfering, through the medium of duties and fiscal regulations, with the raw material of a manufacture which could only be sustained by freedom of trade and production. It was proved by the concurrent testimony of witnesses from all parts, that the cloth made from British wool alone could no longer find a market in Europe, and was even deemed too coarse for the clothing of the labouring classes at home: and that, without a free command of the wool of other countries, a great part of the woollen export trade of Great Britain would be for ever lost. It may well excite surprise that any class of men amongst us should have dared to demand that the manufacturers of the country should be prevented from procuring the materials of their manufacture where they could be obtained cheapest and best; nay, should not only be prevented from exercising this natural and necessary right, but compelled to take from the wool-growers at home, and at a price enhanced by fiscal regulations, what was absolutely unsuited for the purposes of commerce. The disgraceful law of 1819 had already shown that, by refusing to take the wools of other countries, we depressed the price of the raw material abroad, and thus gave an indirect premium to the foreign manufacturer; and that, by forcing our manufacturers to employ wools of inferior quality and higher price, we directly unfitted them for competition in the general market of the world. It was of the repeal of the law of 1819 that the wool-growers thought fit to complain, as having produced the depreciation which had taken place in the price of the clothing wools, not perceiving that, in admitting the depreciation from this cause, they admitted at the same time the magnitude and injustice of a burden, which had been so heavily taxing the manufacturing industry of our own country, and fostering that of others. What, it may be well asked, did the wool-growers hope for by forcing up the price of wool by such expedients? To the mere occupier of the land a forced rise of the raw material could only be beneficial during a passing term. On the termination of the lease, the benefit would go to the owner of the land in the shape of increased rent. Thus, in order to raise the rent of the land, the wool-growers were prepared to lay a tax on every consumer of wool, that is, on every individual in the kingdom, and to cripple the trader in his means to maintain his equality in the foreign markets. It is known that, in these times, the great danger to the manufacturing prosperity of the country is the progress of other nations in those arts in which we have hitherto excelled, and that our relative superiority in such arts can only be maintained by our being enabled to supply the productions of them on the cheapest terms; and granting that the wool-growers could, by means of an ill-judged monopoly, have forced up for a time the price of the native wool, would they not thereby have abandoned a yet more safe and permanent means of effecting the end, namely, that which would have resulted from increasing the demand for the manufactured commodity? The injurious measure contended for was, however, happily resisted, never, it is to be trusted, to be brought forward again; and the trade of wool, by being thrown open to the world, has been placed on a far surer foundation than if it had been made to rest on the narrow and insecure basis of monopoly and restriction." [Low's Domesticated Animals.]

The earliest dress known to have been made of wool was the simla, an upper garment resembling a blanket, referred to in Exodus xii. 34. and xxii. 26. The art of manufacturing woollen cloth was no doubt derived by the Greeks and Romans from either Egypt or Western Asia, and it probably passed into the central and western regions of Continental Europe about the time of the Roman conquest; but when it obtained footing or began to be understood in the British Islands, cannot be very distinctly conjectured. Britain probably contained few or no sheep till some time after the Roman conquest. No mention is made of them till about the beginning of the 8th century; and they could not be very numerous till a general destruction of wolves took place, which happened about the middle of the 10th century. In the reign of Richard I., they were so far increased, that wool was become one of the capital commodities of the nation; but no sooner did it become plentiful and valuable than it fell a prey, first to arbitrary power, and next to the spirit of monopoly. With the

growth of wool in England, or very soon after, the art of manufacturing it commenced, cloths being certainly made not only in the year 1224, but long before; and towards the close of the 13th century, one Thomas Cole, was distinguished by the name of the Rich Clothier of Reading, in Berkshire. One of the greatest clothiers that England ever produced was also a native of Berkshire, John Winchcomb, commonly called Jack of Newbury; he kept about a hundred looms in his house,—and, in the expedition to Flodden Field against the Scots, marched a hundred of his own men, all armed and clothed at his own expense. "If we may be indulged a conjecture," says Smith, in his Memoirs of Wool, "touching the origin of wool-sacks in the House of Lords, as a notable memorial of great consequence, we should imagine it to have been, if at all, some time during this struggle (namely, the resistance of the people to Edward I. levying, by his own authority, forty shillings on every sack of wool exported), to perpetuate the remembrance of the noble stand made on that occasion, and of an allowed indefeasible right in the subject not to be saddled with any tax or imposition by other authority than that of Parliament." The state of woollen manufactures in Scotland about the year 1705, appears to have been as follows:—"They made, of their own wool, stockings at Aberdeen, from ten to thirty shillings a-pair; broad-cloth, about twelve shillings per yard;—fingrins, bayse, serges, trimmings, and all sorts of fine worsted camlets, and other stuffs, very near as good as in England; besides Glasgow plaids, in which, as well as stockings, they excelled greatly all other nations." About the year 1752, great complaints were made by the wool-staplers of the evil done to the fleece by the practice of branding sheep with pitch and tar, and also of the false and fraudulent binding of the fleece, in which it was the custom, for the purpose of increasing the weight, not only to include the worst kind of the wool, such as tail-wool, shank-locks, coated wool, &c., but also clay, stones, sand, dung, &c. To lessen the former of these evils, it was recommended—and the recommendation is worthy of being attended to in the present day,—first, to confine all brands to the buttocks or hinder leg,—second, to limit the size of the brand,—and third, to prohibit the use of pitch and tar to all other marking thought proper to be put on sheep.

"After the year 1773," says Professor Low, "a revolution occurred in manufacturing industry, which may be said to have changed the condition of human society. Machinery was applied to the fabrication of cotton, and the stupendous power of steam was called into more extended action. First came the spinning-jenny, by which a child could direct a hundred spindles and more, all at a time; then the beautiful frame of Arkwright, which required merely that the raw material should be supplied, in order to be spun into threads of surpassing fineness; then the mule-jenny; and last the power-loom, which substituted mechanical for human power in the forming of the cloth. A similar machinery was applied to the spinning and weaving of wool, and the whole processes of the art were changed. The variety, quality, and cheapness of the productions increased in a wonderful degree; and, notwithstanding the amazing extension of the use of cotton in furniture, clothing, and dress, the consumption of wool in England has not only not diminished, but is at this time greater than in any former age. The number of sheep in the British Islands has been variously computed at from thirty to thirty-five millions. Taking the latter sum, which probably falls below the real amount, and assuming the produce, after making allowance for the deficient weight of the wool of slaughtered sheep and lambs, to be 4½ lbs. the fleece, the total quantity produced will be

	157,500,000 lbs.	
Whereof are exported in the raw state, . . .	4,603,799	
Leaving to be manufactured, .	152,896,201 lbs.	
And assuming the price to be 1s. 3d. per lb., the value of the raw material will be .	£9,556,012	11 3
The value of foreign wool imported, 56,700,895 lbs. at 2s. 6d., is	7,087,611	17 6
	£16,643,624	8 9

Supposing, then, the value of the manufactured commodity to be 2½ times that of the raw material, the value of manufactured woollen goods produced in Britain will be £41,609,061 : 1 : 10. This great national manufacture supplies a larger internal consumption than takes place in any other country; and affords a surplus, valued at between six and seven millions sterling, besides yarn, valued at about half a million, for an export trade to all parts of the world, being more than one-eighth part of the whole export trade of the kingdom. The woollen trade is, therefore, of surpassing importance to the nation. It has to contend with the fiscal regulations, and the increasing production and rivalry of other countries; but hitherto the superior capital, machinery, and industry of the country, and the facilities of an extended commerce, have given advantages to the British manufacturer which no European country as yet possesses."—*Smith's Memoirs of Wool.—Bischoff's Comprehensive History of the Woollen and Worsted Manufactures.—Southey's Treatise on Wool.—MacCulloch's Commercial Dictionary.—Bakewell's Observations on Wool.—Youatt on Sheep.—Spooner on Sheep.—Low's Domesticated Animals.—Luccock on Wool.—The Annals of Agriculture.—Parliamentary Papers.—Anderson's Recreations in Agriculture.—The Farmer's Magazine.—The Quarterly Journal of Agriculture.—The Transactions of the Highland*

Society.—Communications to the Board of Agriculture.—Donaldson on Manures.

WOOLLEN RAGS. See Rags.

WOOLLY BLIGHT. See Aphis.

WOOL-SHEARS. See Shearing of Sheep.

WORM. See Worms.

WORM-GRASS. See Spigelia.

WORMIA. A genus of ornamental tropical plants, of the dillenia tribe. The toothed species, *W. dentata*, was introduced from Ceylon to British collections in 1818; and is an evergreen, yellow-flowered, small tree of naturally about 20 or 25 feet in height; and thrives best in a soil of peaty loam. Three other species are known.

WORMING. An operation performed on young dogs for the purpose of preventing them from biting should they happen to become mad. It consists in making an incision underneath the tongue, and drawing out with a hook a small worm-like ligament. It was regarded by many sportsmen of a very recent period, and is still regarded by some, as a preventive of prime importance and great power; but it really is perfectly useless.

WORMS. Invertebrated animals, with soft elongated bodies. The red-blooded worms or annelides constitute one of Cuvier's four classes of Articulata,—the other classes being crustaceans, spiders, and insects; and they are the only invertebrate animals who have red blood. Their body is more or less elongated, and comprises numerous rings, of the character either of segments or of transverse plicæ; their head consists merely of the first of these rings, and does not seem to differ much from the rest, except in the presence of the mouth and the principal organs of the senses; their systems of locomotion do not compose articulated feet, but consist principally of setæ or fasciculi of stiff and moveable hairs, commanded by the contractility of the body; their oral organs, in some instances, amount to little more than a simple tubular orifice,—but in others comprise jaws, more or less strong; their organs of sense consist principally of fleshy or articulated tentacula, and of certain blackish points, which are thought to be eyes, but which do not exist in all the species; their respiration is performed in organs which, in some cases, are developed externally, and in others lie on the surface or dip into the interior; their circulation is carried on in a double and closed system of arteries and veins, which comprises, in some instances, one or several visible hearts or fleshy ventricles; and their nervous system consists of a double knotted or ganglionic cord, similar to that of insects. Almost all, except the lumbrici or earth-worms, are aquatic animals; and several penetrate into holes at the bottom of the water, or construct tubes there with the ooze or other substances, or even exude a calcareous secretion which envelopes them with a sort of tubular shell. The lumbrici, or terrestrial worms, are better known than almost all the multitude of other species taken together, and are noticed in the article Earthworm; and the leeches are the most interesting aquatic species, and are noticed in the article Leech.—Other worms than the annelides are recognised only in popular nomenclature, or belong only to popular classification; and they comprise widely different groups and do not constitute or comprise any one natural class. A great many are larvæ; and most of the others are entozoons. See the articles Larva, Caterpillar, Wireworm, Grub, Worms (Intestinal), and Parasites (Animal).

WORMS (Intestinal). Larvæ, annelides, or entozoons living in the intestines of the larger animals. They have been regarded by grooms, dairy-men, cattle-men, and cow-doctors as the causes of several troublesome diseases in horses and cattle; but they really do very little harm, and seldom challenge the enlightened veterinarian's serious attention. Some have such an economy as to render them essentially innocuous; and others, though armed with powers of evil, are, in general, either too few in number or too well resisted by the functional energies or the organic defences of the viscera to be able to do serious mischief. All, in a general view, are referred to in the article Parasites (Animal); and some of the principal are particularly noticed in the articles Ascarides, Bots, and Filaria.

The long white worm, or common intestinal round worm, *Lumbricus teres*, sometimes occurs in the small intestines of both the horse and the ox. It greatly resembles the common earthworm, and has usually a length of from 6 to 10 inches, and is a sufficiently repulsive and formidable looking animal. If it be numerous, it may consume so much of the mucus and nutriment of the intestines as to operate like a disease, and may indicate its devastations by tightness of the horse's or the ox's skin, roughness of the coat, and a tucked-up state of the belly; but, in general, it can be detected only by being occasionally voided in the fæces. The best treatment of a horse whom it has been discovered or may be strongly suspected to infest, is to give a drachm of tartar emetic in a bran mash every night for a week, and then administer a brisk purgative.—A small species of strongulus frequently accompanies the long white worm in the ox. The denticulated tapeworm, *Tænia denticulata*, small in size and becoming attenuated and sometimes almost filiform toward the neck, has been found occasionally in the abomasum and the small intestines of the ox, and still more rarely in the intestines of the horse. The *Tricocephalus affinis*, a small long worm, with a minute head and an elongated and thread-like neck, sometimes occurs in the cæcum of the ox. The *Amphistoma conicum*, a frequent and abundant entozoon in birds, but here of considerably larger size, often inhabits the rumen and the reticulum of cattle. But these little creatures are objects of interest chiefly to the naturalist, and need not occasion

farmers or horse-owners any concern. The practice of administering calomel and other mercurials as vermifuges is very bad; the administering of turpentine can be serviceable mainly or only in the case of tape-worm; and, in general, the use of vermifuges of any kind for horses and cattle, except in bad cases of ascarides and lumbricus, may be regarded as doing twenty fold more harm than good.

WORMWOOD,—botanically *Artemisia*. A diversified genus of plants, of the chamomile division of the composite order. Six species are natives of Britain, about one hundred have been introduced from other countries, and a good many more are known. A few of the species in Britain are hardy annuals and biennials, the great majority are hardy annual-stemmed perennials, three or four are hardy deciduous shrubs, and upwards of twenty are evergreen shrubs, some of them hardy and the rest requiring either frame or greenhouse protection. The stems of some are simple, and those of others are branched; the foliage of some is smooth, and that of others is hoary or pubescent; the leaves of some are entire, those of others are palmate, and those of most are either pinnate, bipinnate, pinnatifid, or bipinnatifid; the flowers of a few are white or brown or purple, and those of the vast majority have a yellowish-green or herbaceous colour; the habit and foliage and general appearance of some are uninteresting, and those of others are more or less highly ornamental. A few of the species possess medicinal, fragrant, or culinary properties; and a number have been described in our articles Moxa, Southernwood, and Mugwort.

The common wormwood, *Artemisia absinthium*, is an indigenous, perennial-rooted, annual-stemmed herb, inhabiting road-sides, heaps of rubbish, and dry waste places; and it is cultivated in gardens for medicinal and culinary purposes. Its root is branched and somewhat woody; its stems are branched, angled, furrowed, nearly erect, panicled at the summits, and from 18 to 36 inches high; its lower leaves are bipinnate; its upper leaves are pinnatifid or digitated; its leaflets are entire, oblong, and obtuse; and its flowers grow in erect racemes, and are pedicellated, hemispherical, nodding, and of a brownish-yellow colour, and bloom from July till September. This plant emits a strong odour, which some persons reckon fragrant, and others reckon very disagreeable; it has an intensely bitter, slightly pungent, nauseous taste; it acts internally as a tonic and an anthelmintic, and externally as a discutient and an antiseptic, and it acts beneficially in cases of dyspepsy and hypochondria, and has been extensively used also in cases of gout, scurvy, dropsy, and intermittent fever. It contains an essential oil which possesses narcotic properties; and it is freed from this by decoction. The plant loves a dry soil in a shady border; and may be raised either from seeds sown in spring, or from slips or cuttings planted in June or August.

The sea wormwood, or drooping sea wormwood, *Artemisia maritima*, is a perennial-rooted, annual-stemmed indigen of the sea-shores of Britain; and is cultivated in gardens for the same purposes as the common wormwood. Its stems are branched and about 12 or 18 inches high; its leaves are pinnate and hoary; and its flowers have a brown colour, and bloom in August and September. It will thrive in any ordinary garden soil, and may be raised in the same manner as the common species.—The French wormwood, *Artemisia gallica*, inhabits the muddy shores of Britain, and is very similar to the sea wormwood, but about twice as tall.

The Santonica or Siberian wormwood, or Tartarian southernwood, *Artemisia santonica*, is a native of Siberia, Tartary, and Persia, and was introduced to Britain toward the close of the 16th century, and is cultivated in gardens for the same purposes and in the same way as the common wormwood. It has the habits of indigenous field southernwood, but is erect. Its stem is panicled, rather hoary, and from 12 to 24 inches high; its branches are wand-like; its lower leaves are pinnate, much cut, linear, and hoary; its upper or branch leaves are undivided, linear, and very small; and its flowers are solitary, cylindrical, and of a herbaceous colour, and bloom from September till November.

The Roman or Pontine wormwood, *Artemisia pontica*, is a native of Austria, and was introduced to Britain in 1570, and is also cultivated in gardens for the same purposes and in the same way as the common wormwood. Its root is perennial; its stems are branched and about 3 or 4 feet high; its leaves are bipinnate and pubescent; and its flowers are yellow and bloom in September.

The Tarragon wormwood, or simply Tarragon, *Artemisia dracunculus*, is a native of the South of Europe, and was introduced to Britain about the middle of the 16th century, and is cultivated in gardens as a fine aromatic herb for improving the flavour of soups and salads. Its root is perennial; its stems are herbaceous and about 2 or 3 feet high; its leaves are undivided; and its flowers have a herbaceous colour, and bloom in July and August. This plant thrives in any common garden soil, but requires a shady border; and it is raised from bottom offsets in spring, and from cuttings of the stems in May and June.

The tree wormwood or arborescent wormwood, *Artemisia arborescens*, is a native of the countries round the Mediterranean, and was introduced to Britain in 1640. It is an ornamental evergreen shrub, and has long claimed a place among the denizens of shrubberies and pleasure-grounds. Its stem is upright, and from 6 to 12 feet high; its leaves constitute its chief recommendation, and are of two or three sorts, some very much

divided and others a good deal broader, and all have a singular and agreeable effect during winter; and its flowers have a herbaceous colour, and grow in roundish heads, and have very little beauty, and bloom from June till August. This plant is readily propagated from cuttings, planted in a shady place at any time from May till the early part of autumn.

WORT. The infusion of malt which is fermented into beer or ale. Ground malt is mixed with somewhat more than its own bulk of water, at a temperature of between 160° and 180° Fahrenheit, in a cylindrical vessel called a mash-tun; the mixture is covered from the air, and allowed to stand during two or three hours; the liquid portion of it is then drawn off by a cock at the bottom of the vessel; and successive infusions of the same kind, and in the same way, are made upon the residuum till all its extractive principles are sufficiently withdrawn. The liquid thus obtained is wort; and, as appears from the nature of the process, it is simply a watery solution of the extractive or saccharine and amylaceous matters of the malt. It has a brownish-yellow colour, a peculiar smell, and a lusciously sweet taste; and, if it have been properly made, is perfectly transparent. The chief ingredient in it, or rather its essential constituent, is a sugary substance which, when separated from the other ingredients and dried at a temperature of 160° Fahrenheit, forms a brittle mass with a glazed surface, and has a light brown colour and a specific gravity of 1·552. Another ingredient is starch,—which may readily be precipitated by dropping some infusion of nut-galls into the liquid; another is mucilage,—which may be precipitated by means of alcohol; a fourth is gluten, —which passes during the subsequent process of fermentation into yeast; and a fifth in many specimens of wort—though it ought not to exist in any—is a mixture of insoluble matter drawn off from the sediment in the mash-tun, and rendering the liquid more or less slightly turbid. The proportion of starch approaches to little or nothing in the degree in which the grain was thoroughly malted; and the proportion of mucilage is always greater in the last infusions of any preparation of wort than in the first.

The ordinary process for converting wort into ale or beer is described in the article BREWING, and the chemical changes involved in it are described in the article FERMENTATION; but a remarkable variety of the process practised in Bavaria, together with consequent modifications on the chemical changes and results, may be profitably studied in the following passage from Liebig: — "English, French, and most of the German beers, are converted into vinegar when exposed to the action of air. But this property is not possessed by Bavarian beer, which may be kept in vessels only half-filled without acidifying or experiencing any change. This valuable quality is obtained for it by a peculiar management of the fermentation of the wort. The perfection of experimental knowledge has here led to the solution of one of the most beautiful problems of the theory of fermentation. Wort is proportionally richer in gluten than in sugar, so that during its fermentation in the common way, a great quantity of yeast is formed as a thick scum. The carbonic acid evolved during the process attaches itself to the particles of the yeast, by which they become specifically lighter than the liquid in which they are formed, and rise to its surface. Gluten in the act of oxidation comes in contact with the particles of the decomposing sugar in the interior of the liquid. The carbonic acid from the sugar and insoluble ferment from the gluten are disengaged simultaneously, and cohere together. A great quantity of gluten remains dissolved in the fermented liquid, even after the transformation of the sugar is completed, and this gluten causes the conversion of the alcohol into acetic acid, on account of its strong disposition to attract oxygen, and to undergo decay. Now, it is plain, that with its separation, and that of all substances capable of attracting oxygen, the beer would lose the property of becoming acid. This end is completely attained in the process of fermentation adopted in Bavaria. The wort, after having been treated with hops in the usual manner, is thrown into very wide flat vessels, in which a large surface of the liquid is exposed to the air. The fermentation is then allowed to proceed, while the temperature of the chambers in which the vessels are placed is never allowed to rise above from 45° to 50° F. The fermentation lasts from three to six weeks, and the carbonic acid evolved during its continuance is not in large bubbles which burst upon the surface of the liquid, but in small bubbles like those which escape from an acidulous mineral water, or from a liquid saturated by high pressure. The surface of the wort is scarcely covered with a scum, and all the yeast is deposited on the bottom of the vessel, in the form of a viscous sediment. In order to obtain a clear conception of the great difference between the two kinds of fermentation, it may perhaps be sufficient to recall to mind the fact, that the transformation of gluten or of other azotised matters is a process consisting of several stages. The first stage is the conversion of the gluten into insoluble ferment in the interior of the liquid, and as the transformation of the sugar goes on at the same time, carbonic acid and yeast are simultaneously disengaged. It is known with certainty, that this formation of yeast depends upon oxygen being appropriated by the gluten in the act of decomposition; but it has not been sufficiently shown, whether this oxygen is derived from the water, from the sugar, or from the gluten itself; whether it combines directly with the gluten, or merely with its hydrogen, so as to form water. For the purpose of obtaining a definite idea of the process, we may designate the

first change as the stage of oxidation. This oxidation of the gluten, then, and the transposition of the atoms of the sugar into alcohol and carbonic acid, are necessarily attendant on each other, so that if the one is arrested the other must also cease. Now, the yeast which rises to the surface of the liquid is not the product of a complete decomposition, but is oxidised gluten still capable of undergoing a new transformation by the transposition of its constituent elements. By virtue of this condition it has the power to excite fermentation in a solution of sugar; and if the gluten be also present, the decomposing sugar induces its conversion into fresh yeast, so that, in a certain sense, the yeast appears to reproduce itself. Yeast of this kind is oxidised gluten in a state of putrefaction, and by virtue of this state it induces a similar transformation in the elements of the sugar. The yeast formed during the fermentation of Bavarian beer is oxidised gluten in a state of decay. The process of decomposition which its constituents are suffering, gives rise to a very protracted fermentation in the sugar. The intensity of the action is diminished in so great a degree, that the gluten which the fluid still holds in solution takes no part in it; the sugar in fermentation does not excite a similar state in the gluten. But the contact of the already decaying and precipitated gluten or yeast, causes the eremacausis of the gluten dissolved in the wort; oxygen gas is absorbed from the air, and all the gluten in solution is deposited as yeast. The ordinary frothy yeast may be removed from fermenting beer by filtration, without the fermentation being thereby arrested; but the precipitated yeast of Bavarian beer cannot be removed without the whole process of its fermentation being interrupted. The beer ceases to ferment altogether, or, if the temperature is raised, undergoes the ordinary fermentation. The precipitated yeast does not excite ordinary fermentation, and, consequently, is quite unfitted for the purpose of baking; but the common frothy yeast can cause the kind of fermentation by which the former kind of yeast is produced. When common yeast is added to wort at a temperature of between 40° and 50° F., a slow tranquil fermentation takes place, and a matter is deposited on the bottom of the vessel, which may be employed to excite new fermentation; and when the same operation is repeated several times in succession, the ordinary fermentation changes into that process by which only precipitated yeast is formed. The yeast now deposited has lost the property of exciting ordinary fermentation, but it produces the other process even at a temperature of 50° F. In wort subjected to fermentation, at a low temperature, with this kind of yeast, the condition necessary for the transformation of the sugar is the presence of that yeast; but for the conversion of gluten into ferment by a process of oxidation, something more is required. When the power of gluten to attract oxygen is increased by contact with precipitated yeast in a state of decay, the unrestrained access of air is the only other condition necessary for its own conversion into the same state of decay, that is, for its oxidation. The presence of free oxygen and of gluten are conditions which determine the eremacausis of alcohol and its conversion into acetic acid; but they are incapable of exerting this influence at low temperatures. A low temperature retards the slow combustion of alcohol, while the gluten combines spontaneously with the oxygen of the air, just as sulphurous acid does when dissolved in water. Alcohol undergoes no such change at low temperatures, but during the oxidation of the gluten in contact with it, is placed in the same condition as the gluten itself when sulphurous acid is added to the wine in which it is contained. The oxygen of the air unites both with the gluten and alcohol of wine not treated with sulphurous acid; but when this acid is present, it combines with neither of them, being altogether absorbed by the acid. The same thing happens in the peculiar process of fermentation adopted in Bavaria. The oxygen of the air unites only with the gluten and not with the alcohol, although it would have combined with both at higher temperatures, so as to form acetic acid. Thus, then, this remarkable process of fermentation with the precipitation of a mucous-like ferment consists of a simultaneous putrefaction and decay in the same liquid. The sugar is in a state of putrefaction, and the gluten in that of decay."

WOUND. The consequences and proper treatment of wounds, in the domesticated animals, vary according to the nature of the injuries and the situation of the injured parts. If the skin and cellular substance only be injured, the recovery is generally easy and prompt. Division of the muscular fibres, with the necessary concomitant of lesion of the smaller arteries and nervous trunks, may oppose more obstacles to the cure; but neither are these often of a serious description. But should any of the greater arterial or venous trunks be opened, any of the cavities of the body be penetrated, or the internal organs share in the injury, a wound must be considered as presenting tokens of immediate and extreme risk. One of the results of every wound, unless where it affects a part not naturally endowed with sensibility, as the horny crust of the hoof, is a sensation of pain; farther, as all the organs admit into their texture a greater or smaller number of vessels, no wound can occur without an effusion of some portion of the circulating fluid; and lastly, the greater part of the tissues of the body being endowed with some share of contractility, whether animal or organic, another general result of a wound is a separation of its sides, to an extent proportioned to the magnitude of the injury, and to the degree of contractile force possessed by the part which has suffered lesion.

Nature establishes the cure of wounded parts in two ways. The one process is that of immediate adhesion, which is accomplished in a few days, when the wound is technically said to have been united by the first intention; the other is by the slower means of suppuration and granulation, through which the wound is gradually filled up, and a cicatrix ultimately formed, and the process is then entitled the cure by the second intention. The conditions which are favourable to the healing of a wound by the first intention are, rest, approximation of the divided surfaces, cessation of hæmorrhage, and seclusion from the contact of the air. These conditions being obtained, there follows, for a few hours after the accident, a discharge from the wounded vessels of a serous or watery-looking fluid, which then changes into an effusion of what is termed coagulable lymph. This substance displays a strong tendency to organization; and being gradually thickened by the absorption of its thinner parts, it serves as a glue, to bind together the cut surfaces, which is generally accomplished at the end of two or three days, though the union be not as yet firm and perfect. Through this lymph the blood-vessels prolong themselves, and the organization of the new matter being at length fully established, the cure may be said to be completed, the whole process usually occupying less than a week. For the success of this process, a degree of increased action in the parts, denoted by slight heat and redness, is required; but this increased action ought not to amount to inflammation, or, at least, the inflammation must be to a very trifling extent, otherwise the cure will be greatly retarded, and must be finally completed by the second intention. If, on the other hand, there be a deficiency of action, the healing process ceases to go on, and the wound assumes the appearance of a callous fissure, giving origin to a thin watery discharge. The cure by the first intention is that which ought to be attempted on every occasion, where there is the slightest prospect of its success, as it may be effected with great expedition, and presents a small scar, the part remaining clothed with original skin, a covering much better than any substitute which can be formed to supply its place. But if it should prove impossible to attain the conditions necessary for completing the union by the first intention, we must look for the appearance of a different series of phenomena. The pain arising from the injury continues and increases in severity; and towards the beginning of the second day after the accident, other symptoms of inflammation show themselves, such as increased heat and redness, with swelling of the parts closely adjoining. The discharge is at first thin and nearly colourless, though sometimes tinged with blood; and afterwards the surface becomes covered with an effusion of lymph. About the third day, there begin to display themselves a number of minute red-coloured cones, soft, and bleeding on the slightest contact, which denote the commencement of the process of organization in the effused lymph, and are known by the name of granulations. These, on being subjected to maceration, appear to be composed merely of cellular tissue, and do not present any analogy, in point of structure, with the particular organ from which they proceed, or of which they are henceforward destined to form a part. In the mean time, the discharge becomes opaque, and of a yellowish-white colour, possessing the other properties of what has been termed purulent matter, and becoming thicker, more viscid, and of a purer white, as the cure advances. The process of granulation now proceeds, until the whole cavity of the wound be filled with the newly generated substance. A thin blue pellicle is then observed at the edge, which increases in breadth, and proceeding from the circumference to the centre, gradually completes the covering of the wound. During this period, the sensibility of the wounded part decreases, and the heat and painful distention disappear as the inflammation subsides. The newly formed cellular tissue acquires a contractile power, by which the wound is curtailed in its dimensions, and the divided surfaces are brought closer together, the bond of union putting on finally a fibrous appearance and consistency. Lastly, the new-formed skin, from being of a blue colour, delicate in its texture, and highly vascular, becomes changed into a dense, firm, and almost insensible substance, contracting at the same time its dimensions still farther. With this concludes the healthy and natural process of cure by the second intention, which, it may be observed, admits of division into three stages,—those, viz., of inflammation, usually in large wounds accompanied by general sympathetic fever, and lasting from three to six days; suppuration, the duration of which is irregular; and cicatrization, by which the healing of the wound is at length fully accomplished.

A mild degree of inflammation necessarily, as we have seen, accompanies the process of granulation and suppuration; but should this inflammatory action run to excess, or become deficient, the cure is alike impeded. Hence we have wounds which are prevented from healing by excess of action, and wounds whose cure is impeded by defect of action; or, as every wound secreting matter may be considered as an ulcer, we have what are termed irritable and indolent ulcers. The irritable ulcer is attended with acute pain. Its surface is sometimes whitish or ash-coloured, but oftener of a brownish-red. There are no distinct granulations, the margin is abrupt and irregular, and the discharge is thin and serous, often tinged with blood, and frequently so acrid as to excoriate the neighbouring parts. Irritable ulcers occur in subjects whose powers of life have been too highly fostered, and in animals of a delicate and suscep-

tible habit of body. They are also frequently the effect of improper treatment, such as the application of substances too strongly stimulant, the use of undue pressure of straps or bandages, or want of cleanliness. The indolent ulcer, more rare in animals than the former, is distinguished by its thick, smooth, and callous edges, which cause the sore to wear an appearance of great depth. Its surface is smooth, glistening, and destitute of distinct granulations, varying in colour, but generally dark grey or brownish. The discharge is viscid, and usually adheres tenaciously to the surface of the sore. It is often accompanied by a considerable degree of swelling. Neither of these ulcers shows any tendency to cicatrize, until the nature of its action undergoes the necessary change into what constitutes the condition of the simple healthy ulcer, such as has already been described while detailing the process of cure by the second intention. Ulcers of long standing are apt to assume the indolent form, and in this state are found to be of very tedious and difficult cure. We should also notice, that certain disordered conditions of the system tend to delay the healing of wounds. These will, of course, require to be watched for and obviated where possible. The state of the digestive organs, in particular, will often demand a careful attention.

Wounds receive their most common and appropriate classification from the different manner in which they have been produced. We have thus, first, incised wounds, or such as have been caused by instruments having a sharp edge or point; secondly, contused wounds, or such as owe their origin to contact with bodies which act only by their mass, or by the swiftness of their motion, or, if at rest, by the resistance which they offer to the motions of the animal; and, thirdly, lacerated wounds, where the tissues of the body are subjected to too high a degree of tension, to which they yield, and are forcibly torn asunder.

Incised Wounds.—An incised wound is one of the most common accidents to which the lower animals are exposed, and presents itself in a considerable variety of forms. These will admit of being reduced to three principal divisions, first, the simple incised wound, which is susceptible of cure by the first intention; secondly, the suppurative wound, which can be healed only by the process of granulation and cicatrization; and, thirdly, the punctured wound, which differs from the others by its breadth being small in proportion to its depth, and which admits of cure sometimes by the first, and sometimes by the second intention.

Simple Incised Wounds.—The great object, in all cases of simple incised wounds, ought to be to attain an union by adhesion. Some veterinary surgeons tell us, that, in the lower animals, and especially in the horse, it is impossible to achieve a cure by the first intention. They would have spoken more correctly, had they contented themselves with maintaining that such a cure was often a matter of difficulty. Daily experience shows instances of the wound attending bloodletting being united without the formation of matter; and Blaine, with every other veterinarian of eminence, admits the possibility of thus healing far more extensive injuries. The experiments of Duhamel and Hunter show even that portions may be entirely removed from one part of the animal system to another, and yet perfect adhesion be obtained. Yet it must be allowed, that a considerable obstacle to the success of this process of cure is found in the strong tendency to inflammatory action which seems to characterise the horse; and a still greater obstacle in the restlessness of the animal, and the difficulty of subjecting him to due control. But the proportion of successful cases has been too great, where the immediate union has been judiciously aimed at, for the practice to be allowed to fall into disuse; and the attempt may always be attended with this satisfactory assurance, that, even in cases of failure, matters are placed in no worse condition than before, as the cure by the second intention still remains open to us, and what would otherwise have been our first resource may be accomplished still with the same ease as formerly, while the chance of doing better has not been neglected. No wounds can be said to be capable of union by the first intention, excepting such as are recent, and whose margins can be brought into close approximation. The first care, in dressing a wound of this description, ought to be directed towards ascertaining its extent and depth, and the precise nature of the parts involved, by gently separating its sides, washing away the blood by which it is covered, and removing all foreign substances, such as sand, &c., should any be present. The use of the probe may sometimes be necessary, but should be always sparingly applied. The two sides of the division must then be brought into contact, and so carefully retained. For this purpose, in very slight cases, where the injury extends only to the skin, or to the tissues immediately subjacent, the use of adhesive plasters, either alone or aided by the uniting bandage, may be sufficient; and, in such cases, they ought to be preferred; but it will be generally requisite, in considerable wounds, that one or more sutures or stitches should be employed. What is termed the interrupted suture is that usually resorted to, and is performed by means of curved needles, armed with silk, common thread, or fine tape. The needle should be passed from without inwards, at some distance from the margin, and down to near the bottom of the wound, and the one lip being thus penetrated, it must be carried through from within outwards. The sides of the wound must then be brought together, when the ligature may be tied, and its ends cut away. If the wound be extensive, more than one stich will be required, but they should

seldom be nearer each other than an inch. The suture generally ulcerates out about the third or fourth day. Sutures ought not to be applied where the wound is of great depth, or where they would be required to traverse the substance of a muscle, as, in such cases, they cannot be fixed with sufficient firmness, and would besides be a source of great and constant irritation to the contractile fibre. Where the suture has been applied, the use of strips of adhesive plaster, made of diachylon, and spread upon leather or strong cloth, will be advantageous in affording support to the stitches, while they remain attached, and in supplying their place should they have ulcerated out, or been removed on account of their exciting too high a degree of action, to which they sometimes give rise. In order to fix the plasters, the sides of the wound should be shaved or closely shorn, and the strips applied of sufficient length to pass beyond the reach of the exuding moisture, a small space being left between each, corresponding to the place occupied by the ligatures, by which means a free egress will be allowed to whatever matter may proceed from the wound,—a point which ought always to be attended to, whether the strips be used along with the suture or alone. The whole should be covered by a proper light bandage so as to exclude completely the contact of the air.

The application of bandages is a subject well worthy the attention of the veterinary student, as much may be accomplished by their aid in the cure of wounds. Indeed, in favourable situations, they prove often sufficient of themselves to maintain the divided parts in due approximation, so as to set aside the necessity of having recourse to either stitches or plasters, with which, especially the former, it should always be the object of the dresser to dispense, where possible; and that more particularly in examples where there is reason to dread an excess of high irritative or inflammatory action, which such applications have naturally a tendency to provoke or increase, though not, by any means, in an equal degree. Bandages for the purpose of promoting union can be conveniently applied in most wounds of the extremities, and sometimes in those of the head and trunk, while in injuries of the haunches, the buttocks, the shoulders, the breast, the stifle, the flanks, &c., they are of difficult application, and can only be employed as a covering to the part, without at all conducing to the union of the wound by keeping its sides in contact, which must be left to be accomplished by the other means described. The form of the uniting bandage necessarily varies according to the direction of the wound, whether it be longitudinal, transverse, or oblique. When it is desired to draw together the margins of a wound running parallel to the long axis of the limb, the bandage is composed of a single piece of cloth, of a length and breadth proportioned to the extent of surface to be covered. In the middle of this a longitudinal slit of two or three inches in length should be made. The bandage must then be rolled up at both ends, and the slit being applied over the wound, one of the rolled ends should be passed round the limb, and through the slit, when, by pulling the ends, the whole cut surfaces are approximated; and by passing the roller once or twice round the limb, and securing its extremities, the parts are retained and supported in the proper situation. Before applying the bandage, a light soft pledget, thinly smeared with simple ointment, should be laid over the wound, and a compress placed at a little distance on each side. These compresses will receive the principal part of the pressure from the bandage, and will serve to direct it so as to push together the parts at the bottom of the wound. The bandaging of wounds whose direction is transverse or oblique to that of the limb becomes a process of greater difficulty; and we fear that its complicated aspect will be found sufficient to deter many from the trouble of attempting it. But as there may be cases in which the anxious proprietor of a valuable animal may rightly consider, that scarcely any degree of labour and attention can be ill-bestowed in preserving its soundness and handsome appearance, we subjoin the following directions. For the transverse or oblique wound, two compresses and two rolled bandages are required. One of the compresses should be formed of a piece of cotton or linen cloth, as broad as the wound is long, and folded to a convenient thickness, but having one of its extremities left free, which should be divided into several slips. This should be applied above the superior margin of the wound, in a line parallel to its direction, and fixed there by several turns of one of the rolled bandages, which should be continued down to the edge of the division. The other compress is to be formed in the same way, with the exception, that instead of the free extremity being divided into slips, it should be perforated by a number of holes corresponding to the strips of the upper one. This compress must be applied below the lower lip of the wound, and secured there by several turns of the second roller. A soft pledget, thinly covered with some simple ointment, such as the common or Turner's cerate, is then to be laid over the wound, and the strips of the upper compress being passed through the openings in the lower one, the two ends are to be pulled in opposite directions, by which means the whole divided surfaces will be brought into exact contiguity. The ends of the compresses should then be laid flat along the limb, and held by an assistant until they are fixed by continuing the turns of the rollers, between which they should be several times folded for the sake of greater security. Lastly, the ends of the rollers are to be fastened by pins or by a few stitches at the lower part of that division of the limb which has suffered the injury. The uniting bandage should be applied sufficiently tight to insure its

retaining its situation, but not so as to cause any considerable degree of constriction to the limb.

The proper method of removing the dressings is a matter scarcely less worthy of attention than their first application. It will seldom be necessary to attempt their removal before the second or, more frequently, the third day after the injury. Care must now be taken not to expose the animal to unnecessary torment, or the still imperfect cicatrix to risk of damage, by hasty or violent handling. Let the dressings be softened by tepid water where they adhere through the hardening of effused blood or matter; and where plasters have been applied, they should be removed by raising their extremities, and pulling them from each side towards the line of the wound, so as to avoid all danger of reopening its cavity. Long exposure and much handling of the wound should be avoided, and the probe must be sparingly used, if used at all, which will seldom be necessary. Where stitches have been employed, they should be divided and removed, if they have not already ulcerated out; and the precaution of applying fresh strips of plaster before detaching the stitches, may often be adopted with propriety, as a means of insuring constant support, where it is feared that the cicatrix is still destitute of sufficient solidity to maintain its union. The injured parts should be lightly washed before the application of fresh dressings, as want of cleanliness will often prove a serious obstacle to the cure. The intervals which ought to elapse between the subsequent dressings must be regulated by circumstances. It is seldom that they can be required oftener than once in the twenty-four hours; and where the process of union has gone on successfully, even this need not be long continued, as the cicatrix will speedily acquire that degree of consistence which renders it independent of extraneous support; at which period the cure of the wound may be considered as complete. The success of the plan which has been detailed is not likely, in moderately favourable instances, to disappoint our wishes; but if, after exposing it to a fair trial, it be found that the wound shows no decided tendency to unite, it must now be healed by the slower process of suppuration and granulation.

Suppurative Wounds.—Wherever the margins of a wound cannot be brought into close contact, and its surface covered by sound integuments, there can be no hope of a cure excepting through the medium of the suppurative process. A wound may be in this condition either through a loss of substance which may characterize the injury, through neglect in the first treatment, or through such conditions of the general system, or of the parts injured, as are known to be unfavourable to the adhesive union. But we shall, perhaps, best exemplify the method of treatment which seems to recommend itself most to notice as founded on right principles, by following out a case in which it may be supposed that the union by the first intention has been attempted, and has not been attended with success.—If, as frequently occurs, the union be impeded by an excess of what may be termed simple, healthy, inflammatory action, evinced by considerable swelling of the parts adjoining the wound, and by the prominent, firm, and vividly-red appearance of the granulations on its surface, this will ordinarily be best allayed by the use of warm fomentations or poultices; while, in some cases, it may be necessary to have recourse to general or local bloodletting, and a restricted diet; and, on the action being subdued to its proper pitch, dressings with simple ointment, repeated daily, will serve to complete the cure; or, where the margins admit of being approximated to a certain extent, though not wholly, the adhesive plasters may be used.—But if the excessive action be of that kind which leads to the constituting of what we have described as the irritable ulcer, a more serious obstacle will have been placed in our way, demanding a more patient perseverance in the treatment. Our object must, of course, be to reduce the morbid state of excitement in the parts to the just standard; and to effect this, sometimes cold and sometimes warm applications have been recommended. The warm applications are likely to suit the greater number of cases; and they may consist of fomentations with decoctions of chamomile flowers or poppy heads, and emollient poultices. The fomentations should be repeated at least twice daily, morning and evening, for half an hour at a time, and the sore should be covered during the intervals with warm poultices, frequently renewed, composed of sifted oatmeal, turnips boiled and bruised, or linseed meal, with the addition of a little lard or oil. When the irritability lessens, and healthy granulations begin to cover the sore, a piece of soft dry lint may be placed between it and the poultice; and as soon as the ulcer wears that appearance which has been described as marking the progress of healthy granulation and cicatrization, the poultices should be discontinued altogether, as the action of the part must now be considered as proceeding within due bounds, and the farther use of emollients would be apt to induce the opposite condition of deficiency of excitement. The farther treatment will consist of the simple dressings formerly recommended.—Should the action, on the other hand, be deficient, we shall have presented to us those appearances of the injured part which have been described as constituting the indolent ulcer; or, should the action have suffered diminution in a small degree only, we shall find the sore presenting pale and flabby granulations, endowed with little heat and sensibility, and having little tendency to cicatrize. To remedy either of these conditions, we must now have recourse to stimulating applications, such as the common resinous ointment, &c., or lotions composed of camphorated spirits, or of some of the warm tinctures. The repeated moderate ap-

plication of lunar caustic will often be found highly useful in this kind of sore; and washes composed of white or blue vitriol in solution may sometimes advantageously supply the place of the spirituous lotions. But never, even in this condition of a wounded part, should the sore be crammed with powdered blue vitriol, verdigris, or similar substances, as we find sometimes recommended. Ever studious to avoid extremes, the stimulus should be applied so that its effects can be wisely regulated, and stopped as soon as the appearance of the surface indicates that we have attained that due medium of action which shows that the wound is of itself tending to a cure, when we must again have recourse to simple dressings. As the indolent condition of wounds is one which is not commonly observed in the sound horse, but seems rather to be the attendant on injuries occurring to such animals as are of a sickly habit, as are tainted by glanders, or whose constitution has been enfeebled by improper food, or by any considerable evacuation, regard must be had to the state of the general health of every individual under treatment, and such remedies applied as each particular case may demand or admit. In all conditions of wounds, we repeat, the use of bandages, modified as may be necessary, is advantageous, either with the view of serving as active agents in promoting the cure, or merely as coverings, excluding the contact of the air, which is always observed to cause a state of irritation and dryness in sores exposed to its effects, such as is extremely unfavourable to the establishment of a healthy suppuration. In suppurating wounds, with excessive action, they should be applied loosely, as the parts would then suffer by constriction. In such as show deficient action, a moderate degree of tightness is advisable, and often of great service. In the healthy suppurating wound, the bandages should not exercise greater pressure than is sufficient to maintain them in their place.

Punctured wounds are generally produced by the animal coming into contact with the prong of the common stable-fork, a nail, or a sharpened stake; but of course they may be the effect of a thrust with any pointed weapon. A simple punctured wound which has not injured any important internal organ, or penetrated any of the cavities of the body, is usually of easy cure. Much, however, depends upon the nature of the instrument by which the lesion has been effected. If it have been caused by a narrow weapon, having a very sharp point and polished sides, we may look with some confidence towards obtaining a speedy union by the first intention; but should it have been the consequence of a weapon whose obtuse point and ragged edges do not permit it to penetrate without the exercise of considerable violence, the cure will be likely to be more tedious and more difficult, and will usually be concluded only through the medium of the suppurative process. One of the first points which ought to be ascertained, before proceeding to dress a punctured wound, is the precise direction of the injury; and whether or not its orifice be at its lower or most depending part. It should also be our endeavour to discover whether any of the membranous fasciæ, or sheaths by which the muscles are surrounded, have been penetrated, as such a lesion often gives rise to high inflammatory symptoms, requiring special interference in the after treatment. But, whatever be its precise nature, we believe it will always be prudent to attempt, in the first place, a cure by the adhesive union. Some veterinary surgeons, of deserved eminence, recommend that, in every case of this description, especially where the injury is of considerable depth, the external opening should be enlarged, so as to give the wound a conical or funnel shape, thus affording free issue to any discharge of blood and serum, and preventing constriction of the parts on the occurrence of the usual inflammatory swelling; the wound being encouraged to go on to suppuration. This, however, is a measure which it would perhaps be wiser to delay, until it may be called for by the actual approach of the circumstances which it is intended to obviate, but which may chance never to occur. It will be better, therefore, to commence our treatment by the application of adhesive plaster, if there be any retraction of the edges of the orifice; or, where the wound is close, a piece of soft lint should be secured over it, by a soft compress and bandage. If the wound be severe, the animal may be bled, and a laxative dose administered, as precautionary measures. About the third day, or sooner, if the horse appear feverish and restless, the injury should be examined. If every thing have proceeded favourably, the wound will be found to have adhered, and a little further time and ordinary care will be all that is necessary to establish the cure. But, if the parts inflame, and the animal winces much under pressure, showing the presence of severe pain, it will be proper to have recourse to warm emollient poultices, repeated every three or four hours, and to fomentations with warm water, or with a hot solution of sugar of lead, which should be employed each time the poultice is renewed. Should the wound go on to suppuration, it is to be expected, in cases where the injury has not been inflicted in a direction from below upwards, or where the orifice does not form the most depending part, that we shall have collections of matter, which in such cases cannot attain free egress, and which may extend under the membranous sheaths before alluded to, giving rise to the formation of troublesome sinuses. To prevent this, as soon as the actual presence of matter is detected, it should be evacuated by a free incision. The poultices are then to be continued till the action appears to confine itself steadily to the healthy standard, when the cure may generally be completed with the aid of simple dressings.

Contused Wounds.—Wounds of this description are produced by violent blows with a blunt instrument; or, more frequently, by the horse, while in swift motion, being brought into contact with an obtuse object. The contused wound is generally of an irregular form, its margins appearing unequal and ragged, and not unfrequently presenting flaps partially torn away from the neighbouring parts by a degree of force which leaves them bruised and feelingless, and sets aside all hope of a cure by adhesion. This kind of wound usually leads to the development of high inflammatory action, during the suppuration consequent upon which, such portions of the bruised parts as have been too much injured to retain their vitality, are thrown off, leaving a vacuity which is to be covered by the formation of granulations and a cicatrix. In slight cases, however, it is possible that the lesion may not have gone to so great an extent, and that there may still be some prospect of a complete, or, at least, a partial union by the first intention. In any case, it will be proper to bring the divided surfaces into as close contact as possible, placing over them the usual simple dressings, lint, compress, and bandage. It will rarely be advisable to have recourse to the suture, as it would be apt to provoke that intense degree of inflammation, which, in such wounds, we have especially to fear; but strips of adhesive plaster may often be advantageously applied. Acting thus, even if we do not succeed in obtaining immediate union, we are at least likely to render more moderate the after effects, and to hasten a cure. As soon as any active inflammation shows itself, we must at once take off all pressure of plasters, &c., from the wound, and commence the use of poultices; the rest of the treatment being to be conducted on the plan recommended for suppurative wounds. In this class of wounds we must be especially prepared to expect the occasional appearance of symptomatic fever, which must be met as usual by bloodletting, laxatives, and restricted diet.

Gunshot wounds may with propriety be ranked in the class of contused wounds; but as animals employed in the affairs of peace are rarely subjected to this kind of injury, and as a correct knowledge of the appropriate treatment can only be acquired by those who seek to obtain it through experience in the midst of campaigns, it will be proper to abstain from encroaching here upon what must be held to be the peculiar province of the army veterinary surgeon.

Lacerated wounds may be caused by a nail, or other pointed but blunt-edged substance, penetrating the flesh of an animal while in motion, and tearing itself a passage outwards while the motion continues; or they may be occasioned by the bite of another animal, &c. The edges of a lacerated wound are unequal, and a flap torn and raised from the adjoining parts is a frequent accompaniment. The rules for treating this kind of injury do not differ from those applicable to contused wounds, and need not, therefore, be longer dwelt upon; and we may simply remark, that our chance of obtaining an union by the first intention is greater in the lacerated than in the contused wound. [*Abridged from an Essay by Dr. Wilson of Kelso in the Quarterly Journal of Agriculture.*]

Wounds of joints, particularly of large ones, are generally attended by a high degree of inflammatory action, symptomatic fever, and excruciating pain; and as they are usually small and of the punctured kind, inflicted by a thorn or by a sharp stable-fork, they may most readily be closed by the application of the actual cautery; and when they make such an opening as to permit an escape of the synovia, or yellowish, transparent, slippery secretion which lubricates the joint, they ought to be closed with all possible speed.—Wounds of the abdomen, inflicted by the horns of cattle or by sharp pieces of wood in fences, are sometimes so severe as to let out or even lacerate some part of the intestines. If the bowels merely protrude without being injured, a cure may often or even generally be effected by promptly throwing the patient on his back, replacing the bowels, stitching up the wound, and applying a pledget of tow and a wide bandage; but if the bowels have suffered any laceration or contusion, all hope of cure may be foregone, except possibly by means of skilful treatment on the part of a very judicious and experienced veterinarian.—Wounds of considerable nerves are sometimes followed by tetanus or by some other very severe forms of distress; and partial divisions of nerves are always so much worse than complete divisions, that the symptoms which follow them may usually be alleviated by laying bare the nerve at the injured part, and completely dividing it.—See the articles Inflamed Veins, Cut, Bruise, Fistula, Broken Knees, Poll Evil, Ulcer, Abscess, Quittor, Overreach, Strain, Tumour, Fracture, Purulent Matter, Poultice, and Fomentation.

WOUNDWORT. See Golden-Rod, Kidney-Vetch, and Hedge-Nettle.

WRACKGRASS, — botanically *Zostera*. An indigenous, monocotyledonous, aquatic, economical plant of the order Fluviales. It constitutes a genus of itself, and is specifically called the marine; and it takes its popular name of wrack-grass from its general resemblance to sea-wrack, and its scientific name of zostera from the riband-like form of its leaves. It grows on the sea-shore, and blooms in August and September, and is so like some kinds of algæ that it might almost be mistaken for them. It loves a sandy soil, and may be propagated from seeds.

WREN. A group of small British birds, of the warbler family of Passerinæ.

The common wren, Kitty wren, or Jenny wren, *Troglodytes vulgaris*, is a very diminutive and very well known bird; and inhabits all parts of

Europe, and is able to maintain itself in cold countries throughout the winter. Its total length is rather less than four inches; its general plumage has a brown colour, transversely striated with black; its throat and the edge of its wing contain some white; and its tail is short and perked up. It builds in the corners of outhouses, in stacks of wood, or in holes of walls. Its nest is almost oval, and consists chiefly of moss lined with feathers. The eggs amount to from seven to ten, and are very small, and have a white colour, marked with a few red spots; and two broods are produced in the season. The common wren, besides being readily distinguishable by its diminutive size and its perked up tail, may be easily known by its somewhat peculiar habits; for though it flits up and down among the branches of a hedge, it rarely runs up and around the trunk of a tree like the creeper, *Certhia familiaris*, nor does it usually get so high up as the tits, *Pari*, preferring the root-branches and those which hang over water, where gnats and other night-moving aquatic insects lodge in the day-time, overshadowed from the light. On these it banquets both in summer and in winter; and it may frequently be seen about hedges, barns, stables, farm-yards, walls, and piles of wood. It is said to eat small berries, such as those of the elder, and small seeds; but so long as it can find a gnat or a small beetle, it will rarely touch them. From its being a prolific breeder, and its young, though so small, being voracious eaters, the wren must tend greatly to keep down the numbers of several sorts of destructive insects, particularly in gardens and orchards.

The golden-crested wren, *Regulus cristatus*, is the smallest bird in Europe, and is not uncommon in many parts of Britain. It measures only $3\frac{1}{2}$ inches in length, including the tail, which is $1\frac{1}{4}$ inch. It cannot be mistaken for any other bird, being of a greenish-yellow colour, while the common wren is rusty brown; and though the chiff-chaff and the hay-bird are yellowish-green, neither of these has the golden yellow on the crown of the head, which at once distinguishes this pretty bird. A less conspicuous distinction is formed by two white bars, similar to those of the chaffinch, across the wings, caused by the greenish feathers of the wing-coverts being tipt with white. The gold-crested wren seems to delight most in evergreen shrubs and trees, particularly the spruce-fir and cedar; and it never fails to make daily excursions along the hedges in the vicinity, flitting about through the thickest branches, and uttering its small tinkling chirp of *tee, tee, teehy*, at every change of its position. It is not in the least afraid of being approached, most probably owing to its being very near-sighted—a peculiarity of vision no doubt designed by Providence for enabling it the more readily to distinguish the minute insects on which it exclusively feeds. It may, indeed, be easily approached near enough to see its colours distinctly, or even to catch it with a fishing-rod tipt with bird-lime. In consequence of its minute size, it is rather impatient of cold; yet it does not appear to migrate, except perhaps very partially, even in Scotland, where it remains during the severest winters—one or more families of the tiny little creatures keeping each other warm in cold frosty nights, by huddling together as closely as possible under the thickest branches of a spruce or silver fir, or of a furze or ivy bush. They are said, however, to migrate from Shetland and the Orkneys. It is not a little singular, that though they stand hard frost out of doors, yet exposure to frost kills them when tame, as if the protection of a house rendered them less hardy. They are greatly more abundant in Scotland than in England; and in some districts where fir-plantations have been made, they have multiplied prodigiously within the last half-century. No farmer will be apt to accuse them of injuring his crops; but when a gardener, unacquainted with their habits and food, sees them flitting about among his espaliers, his wall-trees, or his rose-bushes, he may think they are busy eating the blossom-buds, as some other birds are well known to do, while they are really doing him essential benefit, by picking up every straggling aphis and bud-weevil which they can find.

The wood-wren, *Silvia sibilatrix*, and the willow-wren or hay-bird, *Silvia fitis*, have a greenish-yellow colour, darkest on the back and wings, and lightest on the breast and belly; and are much brighter in their hues when young than when of full age. The former is $5\frac{1}{2}$ inches long; and the latter is $5\frac{1}{4}$ inches, and has such an elegant form and such pretty colouring as to be popularly designated in Scotland "the busket leddy." Both are birds of passage, arriving in Britain late in April or early in May, and announcing their arrival by their pleasing notes,—those of the wood-wren being shrill, short, and hurried, accompanied by a peculiar shaking of the wings,—those of the hay-bird consisting of a rather continuous, soft, plaintive warble. The hay-bird uniformly lines its snug little nest with a profusion of loose feathers; the wood-wren, on the contrary, never uses feathers, but lines neatly with hair. The wood-wren is most frequently found among tall trees, and may occasionally be seen among "hedge-row elms," as Milton calls them, and among other tall trees in hedges; but the hay-bird delights in small copsewood, and in what may well be termed copsewood hedges, so common in England,—yet is no less common in shrubberies and gardens, often building in the strawberry beds,—for though it does not seem to care about human neighbourhoods, being found in the most wild and solitary places, it is by no means shy, and will not only allow itself to be approached almost as near as the gold-crest, but will even make its way into greenhouses, and,

when the windows are left open, into rooms where plants are kept in pots. The chief food of both species consists of small flies or small caterpillars, such as roll up leaves of trees and shrubs, and particularly the rose-leaf roller or "worm i' the bud," together with all the most destructive species of aphides. Where the birds are plentiful, therefore, they may prove of no little service to the farmer in thinning, on their first appearance, wheat flies, the blue dolphins, the hop-flies, and the turnip or the pea plant-lice. Yet farmers who are unacquainted with their exclusively feeding on insects, are but too apt to class them without distinction, among inimical birds, as if all birds fed alike, and were ready and eager to devour whatever crop they might find cultivated in the fields. Gardeners are even more prejudiced, particularly against the hay-bird, which in some parts of England, they opprobriously call the cherry-chopper, from a notion that it devours cherries. That it is very frequently found on cherry-trees, is most true; and, if watched, it may be seen busily picking among the fruit; yet it really does not touch the cherries, but is in pursuit of the destructive cherry aphis, a species which is particularly injurious, and which commences its ravages on the cherry-leaves about the end of April, exactly at the time when the hay-bird arrives, as if Providence had ordered the insects to multiply at this season to supply the hay-birds with food. No more does the hay-bird ever taste one of the strawberries in the bed where it may have built its nest, or the pease in the adjoining kitchen-garden, its bill indeed being too slender to bruise pease, and its gullet too narrow to swallow them unbruised, even were it inclined to attack them. White of Selbourne, therefore, did not manifest his usual accuracy of observation, when he said, that the willow-wrens, meaning the hay-bird and chiff-chaff, are horrid pests in a garden, destroying the pease, cherries, and currants,—an opinion which he no doubt adopted without due examination from the gardeners. Had he ever procured tame ones, and tried them, when very hungry, with cherries, currants, strawberries, and with green pease, both raw and boiled, he would have soon had ocular demonstration that they would rather starve than eat fruit or seeds. So far, then, from persecuting and killing these birds, as gardeners so frequently do, every means should be taken to encourage them to breed by protecting their nests.

WRIGHTIA. A genus of ornamental, exotic, ligneous plants, of the dog's-bane tribe. Two species are noticed in the article NERIUM; and several other species, all evergreen shrubs, have been introduced to British collections from India and Australia.

WRYNECK,—scientifically *Yunx Torquilla*. A British bird of passage, belonging to the woodpecker group of climbers. It arrives in Britain in the first or second week of April and departs toward the end of August or in the early part of September. It frequents orchards, coppices, plantations, tree-rows, and tall hedges; and it has the same habits as the woodpeckers, yet seeks its food chiefly on the ground, and seldom climbs. It feeds on caterpillars, ants, and other larvæ and insects; and may often be seen near ant-hills, consuming large quantities of these pests of pastures. It takes its name of wryneck from a habit of making curving motions with its head and neck somewhat similar to the undulatory movements of a snake; and, for the same reason, it is called in some parts of England the snake-bird. Its total length is 7 inches; its bill is straight, pointed, and almost cylindrical; its tongue is extensible, and has the same kind of organic mechanism as that of the woodpeckers, but wants the spines; its plumage, in the upper surfaces of the body, has a brown colour, beautifully vermiculated with small blackish waves, and marked longitudinally with black and fawn-coloured streaks—and, in the under surface, is whitish transversely streaked with black; and its tail quills are similar to those of many other birds. The wryneck does not build a nest, but deposits its eggs on the powdery fragments of decayed wood within the hole of a tree. The eggs amount to from 6 to 10, and are white, smooth, and shining, and measure each $9\frac{1}{2}$ lines in length and 7 in breadth.

WULFENIA. A beautiful hardy annual plant, of the figwort tribe. It constitutes a genus of itself; and takes its specific name from its native country, Carinthia; and was introduced to Britain in 1817. It has a height of about 20 inches; and carries blue flowers in July and August; and it will thrive in any common soil.

WURMBEA. A genus of bulbous-rooted, Cape-of-Good-Hope plants, of the melanthium family. Four species, varying in height from 6 to 15 inches, and all loving a somewhat light soil and propagable from offsets, have been introduced to the gardens of Britain. Three of them have white flowers, and the other has purple flowers; all bloom in May and June; and they may be classed in some instances as curious, and in others as ornamental.

WYCH ELM. See ELM.

X

XANTHIUM. See Burweed.

XANTHOCHYMUS. A genus of yellow-flowered, evergreen, tropical, small fruit-trees, of the guttiferous order. Seven species have been introduced to British hothouse collections from India, and one from Guinea; and all very distinctly possess the well-defined peculiar characters of the order to which they belong, and at the same time produce a fruit sufficiently resembling that of *Garcinia mangostana* to win for them, throughout some parts of the East, the popular name of yellow mangosteens. Their generic botanical name of xanthochymus alludes also to one chief character of their fruit, and signifies "yellow juice." Their fruit is a large rounded or oval berry, similar in appearance to a mango, but flatter, smooth, bright yellow, and in some cases about the size of an ordinary apple; and it contains a copious yellow pulp, of similar appearance to liquid gamboge, and has a pleasant acidulous taste. All the species love a rich soil, and require to be raised from seeds, and refuse to fruit unless treated as analogously as possible to the circumstances of their native regions. The painter's species, *X. pictorius*, was introduced to Britain in 1796, upwards of 20 years prior to the introduction of any of the other species; and the following brief notice, written in 1833, of a freely fruiting small plant of it in M. Boursalt's collection in Paris, may be interesting:—"This plant grows in a round box, 18 inches in diameter, plunged in a bark bed in the stove. The soil which agrees with it is pure heath mould, or rather heath mould mixed with common garden soil or turfy loam. The plant is 5 or 6 feet in height, and is devoid of branches for 2 or 3 feet up; the branches then commence, and form a rounded head, of no very great circumference. It is not upon a trellis. The stem at the bottom is not so thick as one's wrist. The plant bears fruit as large as fine green gage plums (*Belles Reines Claudes*), either single or more frequently united in twos, threes, or fours, and with flavescent flowers. It has borne fruit for several years, and receives no particular treatment. It is necessary that it be kept in a hot and moist atmosphere, in a good hothouse; but, above all, the roots of the plant should be constantly kept very warm. If the heat of the tan be weakened, or if the plant be kept any time out of the tan, it is immediately perceivable by the foliage. The fruit is delicious, and always cool, although gathered in a very warm atmosphere, and eaten immediately."

XANTHORIZA. An ornamental, hardy, North-American, evergreen shrub, of the ranunculus family. It constitutes a genus of itself; and is specifically called *apiifolia*, or the parsley-leaved. It was introduced to Britain upwards of 80 years ago. It has a height of about 3 feet, and blooms from February till April; and it loves a soil of sandy peat, and is propagated from suckers.

XANTHORRHŒA. A genus of curious, white-flowered, spring-blooming, evergreen, Australian plants, of the asphodel family. Six or seven species, varying in height from 2 to 5 feet, some shrubby, others herbaceous, and all loving a soil of sandy peat and propagable from suckers, have been introduced to the gardens of Britain. The name xanthorrhœa signifies "a yellow flowing," and alludes to the exudation of a gummy fluid.

XANTHOXYLUM. See Toothache-Tree.

XERANTHEMUM. A genus of hardy, ornamental, exotic, annual plants, belonging to the thistle division of the composite order. The name signifies 'dry flower,' and alludes to the durability of the flower, which is of the kind popularly called eternal or everlasting. Three species, comprising a number of varieties, principally with either white or purple flowers, and all naturally blooming in July and August, have been introduced to Britain from the South of Europe and the Levant. The stem of the earliest introduced and best known species—which comprises varieties with both white and purple flowers, and with both single and double ones—is slender, branched, angular, furrowed, downy, and about two feet high; the branches usually amount to four or five, and are leafy below and bare above, but carry the flowers on their extremity; the leaves are spear-shaped and hoary,—those of the stem sitting close to it yet spreading out from it, and measuring $1\frac{1}{2}$ inch in length and $\frac{3}{4}$ of an inch in breadth,—and those of the branches similar but smaller; and the flowers are solitary, and comprise each a number of florets in one common, scaly, silvery-coloured calyx, and have such a consistence that, if gathered when perfectly dry and kept from the air, they will retain their beauty during a great length of time.

XEROPHYLLUM. A genus of ornamental, exotic, evergreen herbs, of the melanthium family. The name xerophyllum signifies "dry leaf," and is descriptive. Three hardy species, the grassy, the tough-leaved, and the asphodel-like, all about 18 or 24 inches high, white-flowered, blooming in May and June, loving a soil of sandy peat, and propagable by radical division, have been introduced to Britain from North America; and a hothouse medicinal species, *X.*

sabadilla, mistaken by some botanists for a veratrum or a vellozia, about 3 feet high, white-flowered, loving a soil of peaty loam, and propagable from cuttings, has been introduced from Vera Cruz.

XEROTES. A genus of ornamental, diœcious, evergreen, Australian herbs, of the rush tribe. The name alludes to the aridity of the herbage. Upwards of a dozen species, varying in height from 10 to 40 inches, have been introduced to the horticultural collections of Britain; and all love a soil of rich mould, and are propagable by radical division. Some have the female flowers in heads, and the leaves at the top entire; others have all the flowers in racemes, or the female ones in spikes and the male ones in panicles; and others are stemless, and have the branches opposite or whorled, the leaves at the top denticulate, the flowers spiked or panicled, the male ones sessile and imbricated, and the capsules smooth.

XIMENESIA. A genus of ornamental, yellow-flowered, herbaceous, Mexican plants, of the sunflower division of the composite order. Two annual, one biennial, and two evergreen perennial species, all about 2 or 3 feet high, and blooming in the latter part of summer and in autumn, have been introduced to Britain; and the annuals and biennial thrive in any common soil; and the perennials do best in a soil of loamy peat, and, as well as the others, require to be raised from seeds.

XIMENIA. A small genus of ornamental, tropical, evergreen trees, of the olax tribe. The American species, *X. americana*, is a native of the West Indies, and was introduced to the collections of Britain in 1759. Its stem is branched and about 20 feet high; its branches deflect on all sides, and are armed with thorns, and garnished with lanceolate leaves, standing round them without any regular order; its flowers are produced at the ends of the branches, and have a bell-shaped corolla, cut almost to the bottom into three segments which are yellow inside, hairy, and rolled backward; and its fruit are ovate-oblong fleshy drupes, somewhat similar in appearance to plums, and each enclosing a hard nut of the same form. This plant loves a soil of sandy peat, and is propagated from cuttings.—The unarmed species, *X. inermis*, is also West Indian, but is fully twice the height of the preceding, and was not introduced to Britain till 1810, and loves a comparatively rich or somewhat loamy soil.

XIPHIDIUM. A small genus of ornamental, tropical, evergreen herbs, of the hæmodorum tribe. The name alludes to the sword-shaped form of the leaves. Two species, with respectively white and blue flowers, and both about 20 inches high, loving a soil of sandy peat, and propagable by radical division, have been introduced to Britain from the West Indies and Guiana.

XIPHIUM. See Iris.

XYLOBIUM. A small genus of curious, epiphytous, tropical plants, of the orchis family. It is nearly allied to the genus dendrobium at once in name, structure, and habit; for the word xylobium signifies 'to live upon wood,' while the word dendrobium signifies 'to live upon a tree,'—and both are descriptive. Two species, the dirty-flowered and the long-leaved, have been introduced to the orchis-houses of Britain from tropical America. See the articles Orchis and Dendrobium.

XYLOPHAGI. See Bostrichidæ.

XYLOPHYLLA. A genus of ornamental, exotic, evergreen shrubs, of the spurge tribe. The name signifies 'wood-leaf,' and alludes to the rigidity of the foliage. Two species have been introduced to Britain from Siberia, one from India, one from the Bahama Islands, and seven from Jamaica; and all have a height of about 3 feet, and carry yellow and red flowers, and love a soil of sandy peat, and are propagable from cuttings. The Siberian species bear their flowers on the branches, and bloom in July and August, and require little protection; and the other species carry their flowers on the margin of the leaves, and bloom during a longer period than the Siberian ones, and require the heat and protection of the stove.

XYLOPIA. A genus of ornamental and economical evergreen, tropical shrubs and trees, of the custard-apple tribe. Three species, the frutescent, the rough-fruited, and the smooth-fruited —the last naturally about 25 feet high, and the other two about 4 or 5 feet high, and all loving a soil of peaty loam and propagable from cuttings—have been introduced from the West Indies and Guiana to the botanical collections of Britain; and six or seven other species are known. The bark of the silky species is used in its native country for cordage, and is admirably adapted to that purpose; and the wood of the larger kinds is used as timber.

XYLOSTROMA. See Timber.

XYRIS. A genus of ornamental, exotic, evergreen herbaceous plants, of the rush tribe. Eight or nine species have been introduced to the gardens of Britain from Australia and America; and about twenty more are known. One of the introduced species, *X. altissima*, is about 7 or 8 feet high, and the rest vary in height from 6 to 24 inches; one, *X. americana*, has blue flowers, and all the others have yellow flowers; all inhabit bogs,—and the greater number require to be raised from seeds; *X. altissima* blooms in October, and most of the others bloom from June till August.

Y

YACK. See Ox.

YAM,—botanically *Dioscorea.* A genus of exotic, tuberous-rooted, monocotyledonous plants, constituting the type and the main bulk of the natural order Dioscoreæ or Dioscoreaceæ. The characteristics of this order, which readily distinguish its plants from all other endogens, are a large fleshy root, a climbing stem, cordate or angular leaves, and inconspicuous and for the most part greenish or yellowish flowers. About forty species of it have been introduced to Britain; and all these, excepting five or six, belong to the genus dioscorea; and about twenty other species of that genus are known. Two of the dioscoreas in Britain are hardy, one is suited to the greenhouse, and all the others require the heat and protection of the stove; a few have a height of about 3 or 4 feet, and most of the others have a height of from 8 or 10 to 20 or 25 feet; three have divided leaves, four have lobed leaves, two have oblong leaves, and the others have cordate leaves; four or five have whitish or reddish flowers, and most of the others have green or yellowish flowers; one has an ornamental appearance, six or seven are agricultural or culinary, and the rest are interesting only to botanists; a few love a soil of sandy peat or of peaty loam, the rest love a soil of rich mould, and all are propagated by division of the tuberous roots, more or less in the manner of potatoes. All the interesting and useful kinds, unhappily, belong to the stove, and develope their economical value only or chiefly in tropical countries.

The common or cultivated yam, *Dioscorea sativa,* grows wild in the woods of Ceylon and Malabar, and is supposed to have been artificially introduced thence to the West Indies, and is diffused as a cultivated plant over a large portion of the tropical countries of the world, and was introduced as a botanical curiosity from the West Indies to Britain in 1733. Several varieties of it occur wild; and many varieties are in cultivation. The root of one of the most common is as large as a man's leg, of an irregular form, dirty brown on the outside, and white and mealy within; the stems of all are triangular and winged, and either trail on the ground when they have no support, or climb to a comparatively great height, some so high as 20 or 25 feet, when they grow in the immediate vicinity of trees; the leaves are cordate, and have each two ears somewhat like those of arum; and the flowers have a greenish colour, and bloom in August. The roots of this plant constitute one of the most important articles of ordinary food in tropical countries; and are preferred by many persons, whether Indians or Europeans, to potatoes; and they are cooked and used in a variety of ways, both in substance and when ground into a sort of flour, the solid roots being suitable alike for boiling and for roasting, and the flour serving alike for puddings and for bread. Radical cuttings or sets, each containing an eye or bud, are planted in a manner similar to the sets of potatoes; each cutting usually produces 3 or 4 large roots; and in America, the crop is commonly 6 or 8 months in the ground before the roots are taken up for use. In British horticulture, a cutting or set may be planted in a pot of fresh rich mould, the pot plunged in a hotbed of tan, and a little water given till the shoot appears above the surface; and in this way a plant may be obtained of 10 feet or so in height, but without any considerable sized roots.

The prickly-stemmed yam, *Dioscorea aculeata,* is a native of India, and was introduced thence to the hothouses of Britain in 1803. Its roots are esculent and delicate, similar in taste to fine dry choice ones of the common yam, yet somewhat similar in appearance to those of the battatas; its stems naturally attain a height of about 10 or 12 feet; and its leaves are cordate and somewhat similar to those of the common yam.—The wing-stalked yam, *Dioscorea alata,* was introduced from India to Britain in 1739. Its root is much eaten in Malacca and Java; its stems naturally attain a height of about 15 or 16 feet; and its leaves are cordate, and its flowers green.—The bulb-bearing yam, *Dioscorea bulbifera,* is one of the longest known kinds, and was introduced to Britain in 1692; its stems attain a height of 12 or 14 feet; and its flowers are green and bloom in July and August.—The Brazilian yam, *Dioscorea brasiliensis,* was introduced to Britain from Brazil in 1823. Its roots are esculent; its stems rise to the height of about 8 feet; and its leaves are lobed.—The five-leaved yam, *Dioscorea pentaphylla,* is a native of India, and is there called the wild yam, and was introduced thence to Britain in 1768. Its roots are esculent, yet previous to preparation contain much acrimony; its stems attain a height of about 10 feet; and its leaves are divided and quinquefoliate.

YARD. A court. See Farm-Yard.

YARD. A measure. See Measures.

YARD MANURE. See Farm-Yard Manure.

YARD OF LAND. An old provincial superficial measure, of very variable extent, amounting in some counties to 15 acres, in others to twenty, and in others to twenty-four, thirty, or thirty-four.

YARR. See Spurrey.

YARROW. See Milfoil.

YEARLING. A colt, calf, or other young farm animal, which has completed its first year.

YEAST. A peculiar froth or scum, closely allied in chemical composition to gluten, and possessing the property of easily exciting fermentation. It is always generated during the vinous fermentation of vegetable juices and decoctions; and rises to the surface in the condition of a frothy, flocculent, and somewhat viscid substance. The variety of it most commonly in use is collected from the surface of fermenting or fermented malt liquors; and many other varieties are either incidentally obtained from other fermentations or expressly gathered from decoctions made for the very purpose of yielding them. It is insoluble in water and in alcohol; and when exposed to ordinary atmospheric heat and moisture, it soon and gradually putrefies,—when submitted to a moderate heat, considerably above the ordinary atmospheric temperatures, it becomes a dry, hard, slightly cohesive paste, which may be preserved for a long time without undergoing any change,—when heated to redness in close vessels, it is entirely decomposed, and passes into products similar to those which are obtained in the same circumstances from gluten,—and when exposed for a few minutes to the heat of boiling water, it loses its characteristic property of exciting fermentation, yet suffers little apparent change, and eventually reacquires its characteristic property. Is seems to owe its fermentative power to a nitrogenous principle either quite or very nearly identical with gluten; but, in other respects, it has a variable composition, and is much controlled in character by the kind of juice or decoction from which it is obtained, and by the particular circumstances in which it is collected. A specimen of it analysed by Westrumb yielded potash, lime, carbonic acid, acetic acid, malic acid, alcohol, extractive, mucilage, sugar, gluten, and water; and all the kinds of it proper to be used in medicine, or fresh specimens obtained from fermenting beer, probably owe their therapeutic powers entirely to carbonic acid, alcohol, and the bitter extractive of hops. Good beer yeast has a sour vinous odour and a bitter taste, and reddens vegetable blues; and when filtered, the portion of it which remains on the filter is glutinous, and the portion which passes the filter has no power to excite fermentation unless the glutinous matter is restored to it.

"Yeast," says Liebig, "possesses all the characters of a compound of nitrogen in the state of putrefaction and eremacausis. Like wood in a state of eremacausis, it converts the oxygen of the surrounding air into carbonic acid; but it also evolves this gas from its own mass, like bodies in the state of putrefaction. When kept under water, it emits carbonic acid, accompanied by gases of an offensive smell, and is at last converted into a substance resembling old cheese. But when its own putrefaction is completed, it it has no longer the power of inducing fermentation in other bodies. The presence of water is quite necessary for sustaining its properties; for by simple pressure its power to excite fermentation is much diminished, and is completely destroyed by drying. Its action is arrested also by the temperature of boiling water, by alcohol, common salt, an excess of sugar, oxide of mercury, corrosive sublimate, pyroligneous acid, sulphurous acid, nitrate of silver, volatile oils, and in short substances, all of which possess antiseptic properties. The insoluble part of it does not cause fermentation; for when the yeast from wine or beer is carefully washed with water, care being taken that it is always covered with this fluid, the residue does not produce fermentation. Nor does the soluble part of it excite fermentation; for an aqueous infusion of yeast may be mixed with a solution of sugar, and preserved in vessels from which the air is excluded, without either experiencing the slightest change. What then, we may ask, is the matter in yeast which excites fermentation, if neither the soluble nor insoluble parts possess the power? This question has been answered by Colin in the most satisfactory manner. He has shown that in reality it is the soluble part, but that before it obtains this power, the decanted infusion must be allowed to cool in contact with the air, and to remain some time exposed to its action. When yeast is introduced into a solution of sugar in this state, it produces a brisk fermentation; but without previous exposure to the air, it manifests no such property. The infusion absorbs oxygen during its exposure to the air, and carbonic acid may be found in it after a short time. Yeast produces fermentation in consequence of the progressive decomposition which it suffers from the action of air and water. Now when yeast is made to act on sugar, it is found that after the completion of the transformation of the latter substance into carbonic acid and alcohol, part of the yeast itself has disappeared. From 20 parts of fresh yeast from beer, and 100 parts of sugar, Thénard obtained, after the fermentation was completed, 13·7 parts of an insoluble residue, which diminished to ten parts when employed in the same way with a fresh portion of sugar. These ten parts were white, possessed of the properties of woody fibre, and had no further action on sugar. It is evident, therefore, that, during the fermentation of sugar by yeast, both of these substances suffer decomposition at the same time, and disappear in consequence. But if yeast be a body which excites fermentation by being itself in a state of decomposition, all other matters in the same condition should have a similar action upon sugar; and this is in reality the case. Muscle, urine, isinglass, osmazome, albumen, cheese, gliadine, gluten, legumin, and blood, when in a state of putrefaction, all have the power of producing the putrefaction or fermen-

tation of a solution of sugar. Yeast, which by continued washing has entirely lost the property of inducing fermentation, regains it when its putrefaction has recommenced, in consequence of its being kept in a warm situation for some time. Yeast and putrefying animal and vegetable matters act as peroxide of hydrogen does on oxide of silver, when they induce bodies with which they are in contact to enter into the same state of decomposition. The disturbance in the attraction of the constituents of the peroxide of hydrogen effects a disturbance in the attraction of the elements of the oxide of silver, the one being decomposed on account of the decomposition of the other. Peroxide of hydrogen is rapidly decomposed in contact with moist fibrin of blood, an animal substance in a continuous state of decomposition; the oxygen which it contained, in addition to that necessary to form water, escapes with violent effervescence. Now if we consider the process of the fermentation of pure sugar, in a practical point of view, we meet with two facts of constant occurrence. When the quantity of yeast is too small in proportion to that of the sugar, its putrefaction will be completed before the transformation of all the sugar is effected. Some sugar here remains undecomposed, because the cause of its transformation is absent, viz., contact with a body in a state of decomposition. But when the quantity of yeast predominates, a certain quantity of it remains after all the sugar has fermented, its decomposition proceeding very slowly, on account of its insolubility in water. This residue of yeast is still able to induce fermentation, when introduced into a fresh solution of sugar, and retains the same power until it has passed through all the stages of its own transformation. Hence a certain quantity of yeast is necessary in order to effect the transformation of a certain portion of sugar, not because it acts by its quantity in increasing any affinity, but because its influence depends solely on its presence, and its presence is necessary, until the last atom of sugar is decomposed."

Yeast for making bread, as good as any which can be obtained from brewers, or better, may be made in any of the three following ways. Mash about two quarts of malt in a gallon of water; and let it stand about two hours,—then skim it off into another small tub,—and when it is sufficiently cool, add a table spoonful of yeast. This process is the same as brewing, only without adding hops or boiling the wort; and it must be repeated whenever a fresh supply is wanted,—always keeping a little of the former yeast to make the next ferment. The quantity produced is sufficient for a large baking. If the weather be very cold, the tub may require to be placed near the kitchen fire in order to set up the fermentation. Besides the yeast which rises to the surface of the fluid, some will fall to the bottom. —Another:—Boil half a pound of hops for two hours in ten gallons of water; strain the liquid into a tub, stir in half a pound of ground malt, mix it well, stir it occasionally till the liquid become blood-warm, then add one gallon of yeast obtained from a brewer or preserved from your own last making, add also two pounds of flour, mix the whole well together, allow the mixture to ferment during eight hours, and then stir it up and strain it into a barrel, and keep it as nearly as possible air-tight. The produce will amount to about eight gallons, and will have a medium appearance between that of thin brewer's yeast and thick beer, and, if properly made and properly used, will be found to surpass any brewer's yeast for the purposes of baking. If only a gallon or two be wanted, it may be made from proportionate quantities of the ingredients; and if put into a stone bottle, tightly corked, and placed in a cool situation, it will keep good for a long time.—Another:—Boil one ounce of hops in four quarts of water till the hops fall to the bottom of the pan; strain the liquid, let it stand till blood-warm, add to it six ounces of flour and five of sugar, set the mixture near the fire, stir it frequently, and at the end of forty-eight hours add to it four pounds of boiled and finely bruised potatoes. The yeast will be ready next day; and if properly bottled and stored will keep good during a month. See the articles Bread and Fermentation.

Yeast is both an external and an internal therapeutic. When applied to foul and sphacelating ulcers, in union with farinaceous substances in the form of poultices, it corrects fetor, assists sloughing, and renders the purulent secretion healthful; and when administered internally to the human subject, in doses of about half an ounce every two or three hours, in combination with sugar or porter or wine, it acts as an antiseptic and a tonic, and has been thought particularly serviceable in putrid fevers.

Refuse or putrefied yeast, in a state no longer fit for any of its proper purposes as a ferment, and when either made up with other ingredients into a solid compost or diluted with water and applied in the way of liquid manure, is one of the most powerful of known fertilizers, and, even when used in very small quantity, produces great effects on grass-lands, turnips, cabbages, cauliflowers, oleaginous crops, roses, pelargoniums, dahlias, and many other crops and plants which require rich nitrogenous manure.

YELLOW BIRD'S NEST. See Bird's Nest and Monotropeæ.

YELLOW-HAMMER, — *Emberiza Citrinella.* A well known British bird of the conirostrous family of Passerinæ. It is also called the yellow bunting, the yoyt, and the yoldren. Its head and all the under parts of its body are of a pale yellow or straw colour; the hinder part of its neck is tinged with green; its breast is orange-red; and the inner edge of the two external quills of its tail is white. It builds its nest most

commonly in a tuft of grass or other herbage at the side of a hedge or coppice, sometimes as early as the month of March; and it breeds twice and sometimes thrice a-year. The nest is flat and comparatively large, and consists of dried moss, roots, and horse-hair; and the eggs amount to six, and have a white colour, streaked with purple veins. The old birds feed the young exclusively with larvæ and insects; but they themselves prefer seeds and grain, particularly wheat and oats; and in newly-sown fields, they may be seen very busily picking up the grain, from the moment it is sown till the period of its sprouting or brairding. To the earlier sown crops, as these birds continue in small flocks till they pair and separate, they accordingly do no little injury; but after pairing, as there is seldom more than a pair or two in the neighbourhood of one field, the damage which they effect cannot be great, and is partly compensated by the insects which they destroy to feed their young. When the broods are reared, however, and the corn-crops begin to ripen, the one or two pairs become considerably increased in number, and add to the assemblage of sparrows, buntings, and other plunderers, who leave little alongside the hedges but empty husks on the standing-corn. After this period, the yellow-hammers subsist by frequenting stubble-fields; and when the wheat is sown, they live for some weeks on the seed which they find not sufficiently buried, though they are by no means so fond of wheat as of oats. The yellow-hammer does little or no damage to gardens, inasmuch as it rarely visits these, unless when they are in some very secluded place, or in the wilder parts of the country where there are few hedges except those around farm-house gardens.

YELLOW RATTLE. See RATTLE (YELLOW).

YELLOW ROOT. See XANTHORHIZA.

YELLOWS. See JAUNDICE.

YELLOW SULTAN. See CENTAUREA.

YELLOW UNDERWING. See TRIPHÆNA.

YELLOW VETCHLING. See LATHYRUS.

YELLOW WEED. See DYER'S WEED.

YELLOW-WORT, — botanically *Chlora*. A small genus of hardy, ornamental, annual plants, of the gentian tribe. The perfoliate species, *C. perfoliata*, inhabits chalky hills and clay soils in various parts of Britain; and is well worthy of a place among the annuals of the flower-garden. It is very glaucous, and much subject to mildew. Its stems are about 12 or 18 inches high; its leaves are ovate, acute, combined, and perfoliate; and its flowers grow in upright, leafy, many-forked panicles, and are numerous and elegant, and have a bright yellow colour, and unfold themselves only in sunshine, and bloom in June and July. The imperfoliate species, *C. imperfoliata*, was introduced to Britain from Italy in 1823, and very much resembles the perfoliate. Both love a soil of sandy loam, and are easily raised in the ordinary manner of hardy annuals.

YEOMAN. A cultivator of the soil belonging to a high grade of rural society. Yeomen were formerly understood to be freeholders, who cultivated their own land; but they may now be regarded as comprising all respectable or extensive farmers. Sir Thomas Smith defines a yeoman to be "a free-born Englishman who may lay out of his own free lands in yearly revenue to the sum of 40s."

YEW,—botanically *Taxus*. A small genus of diœcious evergreen trees and tall shrubs, of the coniferous order. The flowers of the male plants have a quadripartite perianth, numerous stamens, and peltate anthers: and the flowers of the female plants have a pitcher-shaped four-leaved perianth, and are each succeeded by a fleshy drupe or baccate cone, scaly at the base and perforated at the top. One species grows wild in Britain; and two other species, as well as some exotic varieties of the indigenous one, have been introduced from other countries.

The common or berried yew, *Taxus baccata*, inhabits moist British woods, in situations where it has good, tenacious, damp soil, and is partially or wholly shaded by taller trees; and it also occurs wild in Canada and throughout most parts of Continental Europe. Its stem is straight, and has a smooth deciduous bark, and readily though slowly lifts up its topmost bough, in favourable situations, to a height of from 20 to 30 feet; its branches are large, and spread almost horizontally, yet are so aggregated as to be capable of forming a massive, regular, elegant head; its leaves are two-ranked or pectinate, crowded, flattened, soft, linear, acuminated, about an inch long, of a pale yellowish hue on the young shoots and branchlets, but of a dark and sombre green on the older boughs and over the great body of the tree; its flowers bloom from February till April; and its fruit are drooping, and have a scarlet colour, a glutinous pulpiness, and a sweet mawkish taste. This tree has usually been seen by the present and the last generations of Britons in a state of tortured growth, or in an old, declining, and diseased condition, or within the walls or immediate vicinity of cemeteries,—and is therefore commonly regarded as either an ungraceful or a gloomy object; yet when it stands singly, and is suffered to form its own shape, and to throw freely out its long branches, and to aggregate its boughs into a grand and natural head, it becomes eminently ornamental, and looks at once massive, elegant, and airy,—and when grown under these conditions in parks or on other gay landscapes, it groups most cheerily with any well-selected and well-arranged assemblage of other trees. It used to be planted in and near burying-grounds in Britain in the same way in which the cypress is in other countries; but, excepting in the Irish variety of it in the more ornate kinds of cemeteries, it is now seldom employed in that way; and when the auracarias and the many recently introduced pendulous and fastigiate trees become better known, it will probably lose al-

together its sepulchral associations, and begin to be regarded as solely a cheerful and ornamental plant. It grows slowly, yet is capable of attaining a great size. A beautiful specimen of it, which so long as 35 years ago was 12 feet in girth, stands by the public road side at the margin of the park of Rossdhu in Dumbartonshire; a specimen of about 28 feet in girth formerly stood in the parish of Arrochar, not many miles from Rossdhu; and a specimen of the enormous girth of 52 feet grew in the church-yard of Fortingal, and still survives though in such a rent and separated state as to appear like two trees. The yew was carefully and extensively cultivated in the age of archery on account of the peculiar suitableness of its strong and elastic wood for making bows; and though now not wanted in that way, it might still make large and profitable contributions of its timber for vastly more useful purposes. It cannot indeed be raised so compensatingly in plantations as most other timber trees, on account of the excessive slowness of its growth; but it is admirably suited for growing as underwood, and might yield more profit in that capacity than almost any other plant. Its wood is hard and durable, and takes on a finer polish than any other kind of our indigenous timber. "Besides the uses of it for boughs," says Evelyn, "for which the close and more deeply dyed is the best, the artists in box, cabinet-makers and inlayers most gladly employ it; and in Germany, they used to wainscot their stoves with boards of it; also for the cogs of mills, posts to be set in moist grounds, and everlasting axle-trees, there is none to be compared with it; likewise for the bodies of lutes, theorboes, bowls, wheels, and pins for pulleys, yea, and for tankards to drink out of." "I have only to add in commendation of this tree," says Gilpin, "that its veins exceed in beauty those of most other trees. Tables made of yew, when the grain is fine, are much superior to mahogany; and its roots vie in beauty with the ancient citron."

The foliage of the yew possesses a very perplexing reputation in reference to the domesticated animals; for in some instances, it seems to be indifferent to them, little eaten and seeming neither to help nor to hurt,—in others, it appears to act as a virulent poison,—and in others, though under limited and cautious conditions, it serves well and long as food; and it probably owes this extraordinary discrepancy of character partly to the different circumstances of soil and situation in which it grows, and partly to the different conditions of maturity and succulency, or of season and vitality, in which it is eaten. One of the most noted instances of its innocuousness has long occurred on Inchlonoch in Lochlomond. "That island," says the General Report of Scotland, "is stated to contain about 2,000 yew trees of very perfect growth, some of them being three feet in diameter. As for centuries past, this island has been used as a deer park, and as both the deer and the forester's cows devour the crops of the branches greedily during the winter storms, without any bad effects, the deleterious qualities of this tree have either been exaggerated, or their effects are diminished by use. Even the berries of the yew are greedily devoured by the field-fare and other birds." Yet very many authentic instances are on record of assured poisonings by the yew-tree, which either have ended fatally or have required prompt medical treatment; and all such cases, as well as the opposite ones of expressly and statedly using the foliage as fodder, may best be stated in the words of Youatt in his Treatise on Cattle. "The yew," says he, "is probably the most destructive poison," more so, that is, than common hemlock, water hemlock, water-dropwort, wild parsnip, black henbane, and all similar plants, "especially when a quantity of it is taken unmixed with other food. M. Husard, however, relates that, in Hanover and Hesse, the cattle are partly fed on the leaves of the yew. He examined the trees as they grew in the mountains of those countries, and he found them to be the true yew. In winter, and especially when fodder is more than usually scarce, a portion of yew leaves and branches is mingled with the other food. The quantity of the yew is small at first, but it is gradually increased until it constitutes the greater part of the food; and it has the reputation of materially contributing to the fattening of the beast. The inhabitants of Hanover and Hesse are, nevertheless, perfectly aware of the poisonous property of the leaves of this tree, and are sometimes taught, by dear experience, that it will destroy their cattle, unless it is managed with this degree of caution. M. Husard adds, that on his return to France he determined to put this matter to the test, but he selected the horse instead of cattle as the subject of his experiment. He gave the yew mixed with oats in the proportion of half a pound of the former to a pound and a half of the latter, and the horse did not appear to be in the slightest degree inconvenienced by what he had eaten. This animal, however, was enfeebled and emaciated previous to the experiment; and it occurred to M. Husard that there might be a deficiency of sensibility in the stomach, and in the frame generally, and that, in consequence of this, the poison might not produce its fatal effects. He, therefore, selected a mare in good health and condition, as the subject of a second experiment. She ate the mingled yew and oats, and suffered no inconvenience. He selected another horse as the subject of a third and decisive experiment. He took seven ounces of the yew, and bruised and mixed it with twelve ounces of water, so as to make a kind of electuary, which he gave to a horse which had fasted four hours; an hour afterwards he fell and died. The British agriculturist will scarcely be tempted to make experiments like these, except in times of the greatest scarcity, and then he would act with all the cau-

tion of the Hanoverian, for several instances occur to the recollection of the writer in which the presence of a considerable quantity of other food in the rumen did not preserve the beast from the fatal effects of the yew. Fortunately, it is seldom that cattle browse upon the green yew; the mischief is usually done by the half-dried clippings of the yew-trees, or hedges, which are too often suffered to lie in the way of cattle, and which they will eat, if not with avidity, yet freely. Little can be done in the way of medicine when cattle have browsed on these poisonous plants, and the only hope of the practitioner must be founded on the early and persevering use of the stomach pump. Plenty of warm water should be injected and pumped out, and that repeated again and again; and at length the stomach should be fully distended with water, for the purpose, and in the hope of, producing vomiting. Whether this succeeds or not, a brisk purgative should be next administered, but as cautiously and gently as possible, that it may pass on over the closed floor of the œsophagean canal into the fourth stomach, and not, by the power with which it descends, force open the pillars that compose that floor, and enter the rumen and be lost. Tonics and aromatics will here also follow the evacuation of the stomach, in order to restore its tone."

Three varieties of the common yew occur in shrubberies,—the short-leaved, with comparatively very short leaves,—the procumbent, with so dwarfish a habit that it seldom can attain a height of more than 8 or 10 feet,—and the variegated-leaved, nearly as tall as the normal plant, but of slower growth, and with light yellow blotched or variegated foliage. The normal plant is raised from seeds, and ought to be transplanted in its third year into a nursery, and kept there three or four years; but the varieties, though they may also be obtained from seed, yet, in order to their being had certainly true to their characters, require to be raised from layers; and while the normal plant and the short-leaved and procumbent varieties will do well in any common soil, the variegated-leaved variety is liable to lose all its characteristic properties unless raised and grown in a very barren soil.

The Irish or fastigiate yew, *Taxus hibernica*, *T. baccata hibernica*, *T. stricta*, or *T. baccata stricta*, is regarded by some botanists as a separate species, and by others as a mere though remarkable variety of the common yew. It is distinguished partly by a peculiar form and aggregation of its foliage, but still more and very greatly by an astricted and erect habit of growth, such as renders it eminently suitable for planting, along with the upright cypress, in the vicinity of buildings and among a profusion of tombs and monuments, where straight horizontal lines predominate. It commonly attains a height of about 12 feet.

The Canadian or American yew, *Taxus canadensis*, was introduced to Britain from Canada about 50 years ago. Its habit of growth is more close and compact than that of the common yew; its general appearance is more handsome; its leaves are shorter, more numerous, regularly pectinate, and of a light green colour; and its natural height and habitat and mode of propagation are the same.

The nut-bearing yew, *Taxus nucifera*, is a native of China, and was introduced thence to Britain in 1820. It naturally attains about the same height as the common and the Canadian yews; but it is too tender to be successfully reared or maintained in the open ground in almost any part of Britain.

YOKE. The appliance for coupling two oxen together and harnessing them to the plough. In the strict sense, indeed, it is merely the thick piece of wood which passes over their neck; but in the popular sense, it comprises also the bow which encompasses their neck, the wreathings or stitchings which form the connections and fastenings, and the ring and chains which afford an attachment to the traces. A yoke, in the mytonymical sense, as in the phrase 'a yoke of oxen,' is the same as a team; and yoking, in all the ordinary senses of the word, whether in reference to oxen or horses, to tillage implements or wheel-carriages, is simply the putting of a draught animal into harness.

YOKE OF LAND. A quantity of land which a yoke of oxen might plough in a day.

YOLK. See Egg and Wool.

YPONOMEUTIDÆ. See Ermine Moth.

YTTRIUM. A very rare metal,—the base of the earth yttria. This earth was first found in 1794 at Ytterby in Sweden; and the metal was first obtained in a separate state in 1828 by Wöhler. Yttrium has a scaly texture, a greyish black colour, and a perfectly metallic lustre; it is brittle, and does not oxidize in either air or water; and when heated to redness, it burns with splendour in common air, and with great brilliance in oxygen. Yttria results from its combustion, and is white and shows marks of fusion; it dissolves in solution of potash and in sulphuric acid; it combines with sulphur, selenium, and phosphorus; and most of its salts have a sweet taste,—and many of them an amethyst colour.

YUCCA. See Adam's Needle.

Z

ZAMIA. A genus of curious, exotic, evergreen plants, of the cycas tribe. See the article CYCAS. Twenty-one species have been introduced to the greenhouses and garden stoves of Britain from South Africa, the Bahama islands, and the West Indies. They vary in height from 1 foot to 15 feet; the majority have confluent leaflets and one-celled anthers, and the rest have basal-jointed leaflets and two-celled anthers; and all love a soil of peaty loam or of loamy peat, and are propagated from suckers. The specific names of most are sufficiently indicative of some of their most obvious distinctive characters; as the broad-leaved, the cycas-leaved, the long-leaved, the cycas-like, the three-toothed, the narrow-leaved, the entire-leaved, the repand, the plum-bearing, the woolly, the spiral, the pricking, the spiny, the slender, and the furfuraceous. The most ornamental are the slender, 1 foot high; the Caffrarian, 4 feet; the spiny, 5 feet; the broad-leaved, 6 feet; the repand, 6 feet; and the plum-bearing, 15 feet. Most are liable, like the cycases, to receive the popular misnomer of sago-palms.

ZANNICHELLIA. See HORNED PONDWEED.

ZANTHOXYLUM. See TOOTHACHE-TREE.

ZAPPANIA. A small genus of exotic, evergreen, herbaceous plants, of the verbena family. Two species, the knot-flowered and the stœchas-leaved, both about a foot high and carrying purple flowers in August, were long ago introduced to British hothouses from America; a beautiful variety of the knot-flowered, about 4 inches high and carrying rosy-coloured flowers, was introduced a few years ago from Chili; and 8 or 9 other species are known.

ZEA. See MAIZE.

ZEBRA. See HORSE.

ZEBRA PLANT. See CALATHEA.

ZEBU. See OX.

ZEDOARY. See TURMERIC.

ZEPHYRANTHES. A genus of ornamental, exotic, bulbous-rooted plants, of the amaryllis family. About a dozen species, chiefly about 6 or 9 inches high, most with either white or red or pink flowers, some hardy, others more or less tender, and all loving a fertile porous soil and propagable from cuttings, have been introduced to Britain from various parts of America. The species called popularly the Atamasco lily, and by the old botanists *Amaryllis Atamasco*, and introduced so long ago as the year 1629, is by far the best known, and may serve as a good specimen of the whole. It is a native of Virginia and Carolina, and grows very plentifully there in the fields and woods, and makes a most beautiful floral display in the months of May and June. It attains a height of only about 6 or 8 inches; yet carries almost as large flowers as those of the small orange lily; and is so hardy as to thrive in the open air in Britain, provided its roots are planted in a warm situation and upon a dry soil. The flowers are produced single; and at their first appearance have a fine carnation colour on their outside; but afterwards fade away to a pale flesh colour, or almost to pure white. This plant sometimes blooms also in August.

ZERUMBET. See TURMERIC.

ZEXMENIA. An ornamental, evergreen, herbaceous, yellow-flowered, Mexican plant, of the sunflower division of the composite order. It constitutes a genus of itself; and is specifically and descriptively called the tagetes-flowered,—*tagetiflora*. It was introduced to Britain about 20 years ago; has a height of about 2 feet, and blooms in September; requires some protection in winter; and is raised from seeds, and will thrive in any common soil.

ZICHYA. See KENNEDIA.

ZIERIA. A genus of ornamental, evergreen, Australian shrubs, of the rue family. About a dozen species, varying in height from 3 to 6 feet, have been introduced to Britain. They are not so showy as some others of the multitudes of ligneous beauties which have been brought to this country from Australia; yet they possess much elegance, and well deserve the attention of refined cultivators. The leaves of most or all are trifoliate; the flowers have a four-cleft calyx and a four-petalled corolla, and in most cases are white; and the capsules are four-celled and four-lobed, and contain each four oval compressed seeds. The smooth species, *Z. lævigata*, is peculiarly handsome, and serves as a favourable representative of the whole genus. Its branches are cylindrical, spreading, slender, and smooth; its leaves are opposite, and stand on short smooth footstalks, and are trifoliately palmate; its leaflets are linear, pointed, reflexed or wavy, from half an inch to one inch long, dark green and smooth above, and whitish and very finely downy below; and its flowers grow in corymbs or little loose bunches of from three to ten, and have a white colour with a slight tinge of pink, and bloom from May till July. All the species love a soil of sandy peat, and are propagated from cuttings.

ZIGADENUS. A small genus of hardy, ornamental, North American, herbaceous plants, of the melanthium family. Several species, all about 12 or 20 inches high, with either white or cream-coloured flowers, have been introduced to

Britain; and they love a soil of sandy peat, and are propagated by radical division.

ZINC. An abundant and very useful metal. It occurs in a metallic state, combined with sulphur and iron, in the form of blende; and in an oxidized state, combined with silica, in the form of red zinc ore,—and combined with carbonic acid, in the forms of electric calamine and common calamine. The sulphuret or blende comprises three varieties,—yellow, brown, and black; and the common calamine also comprises three varieties, — crystallized, compact, and earthy. Zinc was not known to the ancient Greeks, though contained in the cadmia which they used in the manufacture of brass; nor was it known, in its proper or separate state, to any Europeans previous to the third decad of the eighteenth century, though abounding in ores and minerals with which multitudes of them were familiar. It seems indeed to have been worked and used from a somewhat remote period by the Hindoos and the Chinese; but it was not obtained in a separate state in Europe till the year 1721, and was not obtained by the process of distillation till 1742. The ores of it occur in the carboniferous limestone and magnesian limestone formations in England and in many other parts of the world; and are usually associated with the ores of other metals, particularly those of iron, lead, copper, arsenic, and cadmium. It is procured in large quantities from calamine, and in still larger ones from blende, by means of heat and carbonaceous matters, in the process technically called distillation by descent,—the blende being first crushed, picked, and roasted. "The ore is then washed to separate the metallic particles from the lighter parts; and is then ground in a mill with one-eighth of its weight of charcoal; and put into large earthen jars placed in a circular furnace, through the bottom of each of which passes an iron tube, which goes through the floor of the furnace into a vessel of water placed beneath. The cover of each jar is firmly and accurately luted on, so that the reduced zinc, as it is elevated by the strong heat of the furnace, not finding a vent to escape by the top, descends through the iron tube into the water, and is there condensed in small metallic drops, which are afterwards melted and cast into ingots." The portions which first come over are generally very impure, containing admixtures of arsenic and cadmium; and the succeeding continue to be of the same character so long as the vapour burns with what the workmen call a brown blaze,—and should all be rejected as unfit for any of the ordinary uses of zinc;—and even the subsequent and best portions, or those which rise during what the workmen call the blue blaze, are never quite pure,—always containing some iron, and often containing also traces of arsenic, cadmium, lead, copper, charcoal, and sulphur; but they can be freed from their impurities by afterwards exposing them to a white heat in an earthen retort with its receiver full of water, and there subjecting them to re-distillation. A large proportion of the best zinc of commerce, bearing the name of spelter, is imported into Britain from Upper Silesia, by way of Hamburgh and Belgium.

Zinc has a brilliant metallic lustre, and a bluish-white colour. Its fracture is shining and lamellated; its hardness makes strong resistance to the file, yet allows a black stain to be given to the human fingers by rubbing; and its specific gravity varies from 6·861 to 7·1. At low or ordinary temperatures, it is brittle, and may be easily split or broken by a properly directed blow; at any temperature between 212° and 400° Fahrenheit, it is so malleable and ductile that it can be hammered or rolled into sheets of considerable thinness; and at all higher temperatures, it is very brittle, and can be pulverized in a mortar. Its malleability is considerably diminished by the impurities which are naturally combined with it; and is correspondingly increased either by the comparative purity of the ores from which it is obtained, or by the comparative care and refinement of the process in which it is separated. Zinc fuses at 680° Fahrenheit; and, when slowly cooled, crystallises in four-sided or six-sided prisms; and if subjected in close vessels to a white heat, it distils over unchanged. By exposure at ordinary temperatures to the action of air and moisture, it undergoes little change; but by exposure at the temperature of fusion to the air, it rapidly oxidizes, and forms the white oxide popularly called flowers of zinc; and by similar exposure at considerably higher temperatures, probably from about 940° upwards, it burns with a dazzling white flame, and passes with such violence into the state of oxide as to be completely volatilized during the combustion. It dissolves and oxidizes in all the mineral acids; and, when aided by a small portion of sulphuric or of muriatic acid, it decomposes water, and gives off a minute portion of its substance into solution with the liberated hydrogen.

Zinc is extensively used for making baths, water-cisterns, pipes, spouts, filings for fire-works, various kinds of plates, voltaic batteries, and many varieties of objects for which lead and copper were formerly employed. It is used also for covering roofs, and for a number of architectural purposes; and has been introduced, in various ways, to the fitting up and furnishing of the farmery. But though it has the recommendation of being but very slightly tarnishable and of never accumulating a coat of oxide, it is, in many circumstances, a highly objectionable material for pipes and cisterns on account of its voltaic action upon water, and for architectural purposes on account of its comparatively easy and very keen combustibility. Several preparations of it are of great service in medicine; and three of these are noticed in the articles Calamine, White Vitriol, and Tutty.

The protoxide or white oxide or flowers of

zinc obtained by the combustion of the metal, is a light flocculent powder, inodorous, insipid, infusible in the fire, insoluble in water or in alcohol, unalterable in the air, and of a pure white colour at common temperatures, but yellow while cooling from a state of lowered heat. It is a strong salifiable base, combining readily and thoroughly with acids, and forming regular salts, most of which are colourless. It combines also with some of the acids. It appears to consist of one equivalent of zinc and one equivalent of oxygen; but it often contains small portions of carbonic acid; and, as sold in the shops, it is not unfrequently adulterated with chalk or with white lead. It possesses tonic and antispasmodic properties; and has been given in very minute doses in cases of chorea, epilepsy, and hooping-cough; and is the active ingredient in a moderately astringent and stimulating ointment for the cure of ringworm and of chronic inflammation of the eyes.

The acetate of zinc is formed in a state of solution by mixing a solution of sulphate of zinc with a solution of acetate of lead in proper proportions,—the bases and the acids of the two salts making a mutual interchange of combination, and the resulting sulphate of lead being thrown down as a precipitate; and the solution of the acetate of zinc thus formed has long been known as a valuable application for chronic ophthalmia. —A tincture of the same salt is made in a somewhat similar but more operose manner; and serves also in dilution as a good external astringent; and might likewise be advantageously employed as an internal remedy for debility in the digestive system.

The chloride of zinc, popularly called butter of zinc, is formed by the combustion of zinc filings in chlorine gas, and may be obtained also by evaporating muriate of zinc to dryness, and then heating it to redness in a glass tube. It consists of one equivalent of zinc and one equivalent of chlorine; it has a soft consistence,—alluded to in its popular name of butter; and it deliquesces on exposure to the air, being then reconverted into muriate.—Bromide and iodide of zinc may be formed in a similar way to the bromide and the iodide of iron.

ZINGIBER. See Ginger.

ZINNIA. A genus of handsome, hardy, American annual plants, of the sunflower division of the composite order. Eight species, all about 2 feet high, have been introduced to Britain. The few-flowered, *Z. pauciflora*, is the longest known, and has sessile yellow flowers; and all the others have pedunculate and either red or scarlet flowers; while the elegant, *Z. elegans*, comprises both a splendid scarlet-rayed variety and a white-rayed variety. The many-flowered, *Z. multiflora*, blooms so long as from June till October, and the elegant from June till September; and the others bloom either in July and August or in June and July. The slender-leaved, the narrow-leaved, the revolute, and the hybrid thrive in any common soil; and the others, in order to do well, require a soil of rich mould. The elegant combines breadth and beauty of flower more than most hardy or half-hardy annuals; and is a high favourite with many amateur florists, both for the open ground and for small selections of house annuals.

ZIRCONIUM. A rare and simple metallic or quasi-metallic substance,—the base of the earth zirconia. It is prepared from hydrofluate of zirconia with the aid of potassium, potash, and the spirit-lamp; and was first obtained in a separate state in the year 1824. It is a black powder, capable of being pressed into thin shining scales, but with very slight metallic lustre and very feeble coherence of its particles; it does not conduct electricity; it does not oxidize when boiled in water; it yields with great reluctance to the action of sulphuric, muriatic, and nitro-muriatic acids; it readily dissolves in hydro-fluoric acid, with disengagement of hydrogen; and when heated in the open air, it ignites before becoming luminous, burns with a bright flame, and is converted into zirconia.

Zirconia was discovered in 1789 by Klaproth in Ceylon. It has a similar appearance to alumina; is tasteless, odourless, insoluble in water, and so hard that it will scratch glass; it has a specific gravity of 4·3: and, when pure, is of a white colour,—but generally exhibits a yellowish tinge in consequence of the presence of iron. It becomes vividly phosphorescent when strongly heated before the blow-pipe; it combines with acids to form salts, similar in most respects to those of alumina,—but precipitable from solution by any of the pure alkalies; and, when thrown down from any of its salts by ammonia, and afterwards ignited, dried, or even washed with boiling-water, it acquires the power of completely resisting the action of the acids.

ZIZANIA. See Canada Rice.

ZIZIPHORA. A genus of ornamental exotic plants, of the labiate order. Four perennial and six annual species have been introduced to Britain from Siberia, Caucasus, Tauria, Spain, and the Levant; and several more are known. The introduced species are hardy, and vary in height from 6 to 18 inches, and present more or less close resemblances to thyme, basil, savory, and pennyroyal, at once in foliage, flower, and fragrance; and have either red, purple, lilac, or pink flowers. The perennials have a trailing habit and are suitable for rockwork; and three of them, the thick-flowered, the mediate, and the serpyllum-like, are evergreens, and may be propagated from cuttings. All the annuals will thrive in any common soil.

ZIZYPHUS. See Jujube.

ZOOLOGY. That part of natural history which treats of animals. It is not confined to a description of the external forms of animals, but embraces all the phenomena of life and animal

motion; the internal organization of each individual part; the processes of digestion, assimilation, nutrition, secretion, and reproduction; the wonderful instincts, the varied dispositions, and the different degrees of intellect, manifested in the animal creation, from the half-vegetable zoophyte up to man.

Although it cannot be doubted that the attention of men was early attracted to an observation of the habits and natures of the lower order of animals, Aristotle seems to have been the first who furnished the world with any methodical information on this subject. His work contains a great number of facts and observations. He compares the organization of the lower animals, in its different parts, with that of man, and treats of their mode of generation, habits, organs, &c., with great clearness and sagacity; and his principal divisions of the animal kingdom are so well founded that almost all of them are still substantially admitted. Among the Romans, zoology does not appear to have been at all cultivated until the time of Pliny, who is the only Roman zoologist worthy of notice. His work (*Historia Naturalis*) contains multitudes of original traits, though it is only a compilation, and describes the habits and dispositions of animals with great felicity. He adopted, without examination, many fabulous stories, and too often neglected important details. Ælian was far inferior to the two above-mentioned writers, and his Natural History of Animals may be considered as the source of all the falsehood and error which so long disgraced this branch of natural history. Apuleius, and Athenæus the grammarian, are the only names that deserve mention, from the time of Ælian and Pliny to the beginning of the sixteenth century; and they added nothing to the stock of zoological science. At the latter period, flourished, among others, Belon, a French physician, who made the closest approach of any author of that time to anything like systematic classification, in his *De Aquatilibus*, and particularly in his *De la Nature des Oiseaux* (Paris, 1555, folio); Salviani, author of a treatise, *Aquatilium Animalium Historia* (Rome, 1554, folio), which is superbly illustrated; Conrad Gesner, whose *Historia Animalium* (Zürich, 1550—1587, 4 vols. folio), arranged in alphabetical order, forms the foundation of modern zoology; and Aldovrandus, the most laborious of compilers, who devoted sixty years to his work on natural history, in fourteen volumes, folio, of which the greater part was published after his death. These earlier writers were followed, in the next century, by Redi and Swammerdam, to whom entomology is so much indebted, and by Ray, the first naturalist, from the time of Aristotle, who produced anything like a scientific arrangement. The works of Ray, under his own name, are *Synopsis Quadrupedum et Serpentum* (1683, 8vo.); *Synopsis Avium et Piscium* (1713); and *Historia Insectorum;* and he is also considered to have had a large share in the compositions of his pupil Willoughby. But it was reserved for Linnæus to raise natural history to the rank of a science. Gifted with extraordinary powers of invention and discrimination, a most retentive memory, an unrelaxing industry, and the most ardent zeal in the cause of science, this great man observed, with the acutest sagacity, the subtlest affinities of organized nature. The general character of his works is order, precision, clearness, exactness of description, and an accurate knowledge of relations in detail. Buffon adorned natural history with the charms of eloquence, and was the first who extended its popularity beyond mere scholars and men of science. He was occasionally carried, by the force of his imagination, into unfounded hypotheses; yet he had a truly philosophical spirit, could observe facts, and compare results, and possessed extensive information. The four great naturalists whom we have had occasion to mention, have exhibited nature under different aspects. Aristotle has shown us the profound combination of its laws; Pliny its inexhaustible riches; Linnæus its wonderful details; and Buffon its majesty and power. Since the time of Buffon, all the departments of zoology have been cultivated with a zeal, a minute accuracy, and an extensiveness of research, before unequalled. Our limits will not allow us to mention all those who have distinguished themselves in the cultivation of the whole field of the science, much less those who, confining themselves to particular branches of it, have yet rendered most important services by the exactness of their researches and the novelty of their views. Among the Germans, Illiger and Blumenbach hold the first rank as zoologists; but it is to France that we are chiefly indebted for the strong impulse which has been given, in our times, to the progress of natural science, and of zoology in particular. The name of Cuvier alone sufficiently indicates the brilliant triumphs of natural history in that country.

We have already treated, at some length, of some parts of this extensive subject, in the articles Animals, Generation, Gestation, &c., and of the nomenclature of particular classes of animals in the articles Insects, Ornithology, &c.; and we shall now proceed to give some notice of the principal methods of classification pursued by eminent zoologists, and shall make particular mention of the classification of the mammiferous animals. The immense number of facts embraced by natural history could never be retained in the memory without an arrangement of divisions and subdivisions founded upon some distinguishing characteristics. Aristotle's system of arrangement was simple, resting on divisions derived mainly from the external structure, food, habits, and locality. But though neither human nor comparative anatomy was then sufficiently cultivated to enable him to make the internal structure of animals the basis of his divisions, yet Aristotle was not insensible to the advantages of a more scientific distribution, and, with his usual sagacity, recommends to succeeding writers to turn their attention in that direction. Ray followed the advice of the great master, and remarked the great distinction, that some animals possessed lungs and a sanguineous system, while others were destitute of both. Linnæus, proceeding on the general arrangement of Ray, but with many extensions and improvements, divided the animal kingdom into six classes, founded mainly on the differences in the respiratory and sanguineous systems.

Class I. *Mammalia.* All suckle their young; the heart has two auricles and two ventricles; blood red and warm; viviparous.

Class II. *Aves* (Birds). Characters of sanguineous system as in first class; viviparous.

Class III. *Amphibia.* Heart one auricle and one ventricle; blood red and cold; respiration voluntary.

Class IV. *Pisces* (Fishes). Heart and blood as in *amphibia;* respiration by gills.

Class V. *Insecta.* Heart one ventricle and no auricle; sanies cold, colourless; antennæ, or feelers.

Class VI. *Vermes* (Worms). Characters as in V., except no antennæ, but tentacula.

He then subdivides the *Mammalia* into seven orders, the distinctions of which are taken from the difference in the number, form, and situation of the teeth, without, however, neglecting the feet.

Order 1. *Primates.* Four incisors in each jaw, and one canine.—Genera: *homo, simia, lemur, vespertilio.*

Order 2. *Bruta.* No incisors.—Genera: *rhinoceros, elephas, trichechus, bradypus, myrmecophaga, manis, dasypus.*

Order 3. *Feræ.* Six conical incisors in each jaw, for the most part.—Genera: *phoca, canis, felis, viverra, mustela, ursus, didelphis, talpa, sorex, erinaceus.*

Order 4. *Glires.* Two incisors in each jaw; no canines.—Genera: *hystrix, lepus, castor, mus, sciurus, myoxus, cavia, arctomys, dipus, hyrax.*

Order 5. *Pecora.* No fore-teeth in the upper jaw; six or eight in the under.—Genera: *camelus, moschus, giraffa, cervus, antilope, capra, ovis, bos.*

Order 6. *Bellucæ.* Obtuse fore-teeth in each jaw.—Genera: *equus, hippopotamus, sus, tapir.*

Order 7. *Cete.* No uniform character of teeth; aquatic pectoral fins; spiracula.—Genera: *monodon, balæna, physeter, delphinus.*

The other classes are subdivided in a similar manner. We shall enumerate only the orders. The distinctions of the *Aves* are taken chiefly from the beak; but the tongue, nostrils, feet, and other parts, are sometimes called in.

Order 1. *Accipitres.*
——— 2. *Picæ.*
——— 3. *Anseres.*
——— 4. *Grallæ.*
——— 5. *Gallinæ.*
——— 6. *Passeres.*

(See Ornithology.)

The *Amphibia* are divided into two orders.

Order 1. *Reptilia.* Furnished with feet, and breathing through the mouth. (See Reptiles.)

Order 2. *Serpentes.* Destitute of feet, and breathing through the mouth.

The fourth class, *Pisces*, is subdivided into six orders, the characters of which are taken from the belly-fins.

Order 1. *Apodes.* No ventral fins; embraces the eel kind, torpedo, &c.

Order 2. *Jugulares.* Ventral fins placed before the pectoral; cod, blenny, &c.

Order 3. *Thoracici.* Ventral fins under the pectoral; sucking-fish, goby, plaice, doree, &c.

Order 4. *Abdominales.* Ventral fins placed behind the pectoral; skate, salmon, pike, &c.

Order 5. *Branchiostegi.* Gills destitute of long rays; sun-fish, pipe fish, &c.

Order 6. *Chondropterygii.* Cartilaginous gills; lamprey, ray, shark, &c.

The fifth class, that of *Insects*, is divided into seven orders, the characters of which are mostly taken from the differences observed in the number and texture of the wings.

Order 1. *Coleoptera.*
——— 2. *Hemiptera.*
——— 3. *Lepidoptera.*
——— 4. *Neuroptera.*
Order 5. *Hymenoptera.*
——— 6 *Diptera.*
——— 7. *Aptera.*

The sixth class, *Vermes*, is subdivided into five orders.

Order 1. *Intestina.*
——— 2. *Mollusca.*
——— 3. *Testacea.*
——— 4. *Zoophyta.*
——— 5. *Infusoria.*

The arrangement of Linnæus, with all its advantages, had its defects. By confining himself too much to one kind of character, he often throws together subjects widely remote in their general appearance and economy; but he has carried the art of distribution, and the management of characters, to such a degree of clearness and brevity, that any person familiarized to his language may easily find the name and place of any being he wishes to observe. It still remained a desideratum to arrange the facts, of which the science treats, in a series of propositions, so graduated and successively subordinate, that the whole might represent the actual relations of living beings. For this purpose, it was necessary to group animals according to their different properties or organizations, so that those contained in such a group should bear a stronger natural resemblance to each other than to any individual of a different group. This arrangement is termed the *natural* method, for the formation of which zoology offers great facilities. In the arrangement of Cuvier, the completest and most scientific yet presented to the world, the great division of the animal world rests on the nervous and sensorial, and not on the circulatory and respiratory systems. From the study of the physiology of the natural classes of vertebrated animals, Cuvier discovered the respective quantity of respiration, the reason of the quantity or degree of motion, and, consequently, the peculiar nature of that motion. This last gives rise to the peculiar form of their skeletons and muscles; and with it the energy of their sensations, and the force of their digestion, are in a necessary relation. Thus zoological arrangement, which had hitherto rested on observation alone, assumed a truly scientific form. Calling in the aid of comparative anatomy, it involves propositions applicable to new cases, and thus becomes a means of discovery as well as a register of facts; and, by correct reasoning, founded on copious induction, it partakes of the demonstration of mathematics, and the certainty of experimental knowledge. Having examined the modifications which take place in the organs of circulation, respiration and sensation in the invertebrated animals (a title first given by Lamarck, instead of the erroneous one of *white-blooded* animals, by which they were previously distinguished), Cuvier has formed a new division, in which these animals are arranged according to their actual relations. The following is a view of the system as exhibited in the

second edition of the *Règne Animal*, published in 1829 (5 vols., 8vo.) Of the four great divisions into which the animal kingdom is divided—*Vertebrated*, *Molluscous*, *Articulated*, and *Radiated* animals—and of their general subdivisions, an account is given in the article ANIMAL.—Four classes are comprised in the *Vertebrata*,—*Mammalia* or suck-giving animals, *Aves* or birds, *Reptilia* or reptiles, and *Pisces* or fishes. See the articles ORNITHOLOGY, REPTILES, and FISHES. The class *Mammalia*, is subdivided into eight orders, as follows:—

ORDER I.
BIMANA.

Having hands at the anterior extremities alone. One species—man.

ORDER II.
QUADRUMANA.

Having hands at the four extremities.
Simia (Monkey).
Ouistiti.
Makis, or *Lemurs*.

ORDER III.
CARNASSIERS.
FAMILY 1.
CHEIROPTERA.
Vespertilio (Bat).
Galeopithecus.

FAMILY 2.
INSECTIVORA.
Erinaceus (Hedgehog).
Tendrac (*Centenes*, Illig.).
Cladobates (Tupaia).
Sorex (Shrew).
Mygale (Desman).
Chrysochloris.
Talpa (Mole).
Condylura.
Scalops (Shrew-Mole).

FAMILY 3.
CARNIVORA.
TRIBE 1.
PLANTIGRADE.
Ursus (Bear).

TRIBE 2.
DIGITIGRADE.
Mustela (Marten).
Canis (Dog).
Viverra (Civet).
Hyæna.
Felis (Cat).

TRIBE 3.
AMPHIBIOUS ANIMALS.
Phoca (Seal).
Trichecus (Morse).

ORDER IV.
MARSUPIAL ANIMALS.
Didelphis (Opossum).
Dasyurus.
Phalangista.
Potorous (*Hypsiprymnus*, Illig.).
Macropus (Kangaroo).
Koala (*Lipurus*, Goldf.) *Phascolarctos*.
Phascolomys (Wombat).

ORDER V.
GLIRES (RODENTIA).
Sciurus (Squirrel).
Mus (Rat).
Helamys (*Pedetes*, Illig.).
Spalax.
Orycterus.
Geomys (*Pseudostoma*, Say).
Diplostoma.
Castor (Beaver).
Couia (*Myopotamus*, Comm.).
Hystrix (Porcupine).
Lepus (Hare).
Cavia (Guinea Pig).

ORDER VI.
EDENTATA.
TRIBE 1.
TARDIGRADE.
Bradypus (Sloth).
Megatherium (fossil).

TRIBE 2.
COMMON EDENTATA.
Dasypus (Tatou).
Orycteropus.
Myrmecophaga (Anteater).
Manis (Pangolin).

TRIBE 3.
MONOTREMA.
Echidna (Spinous Anteater).
Ornithorhynchus (*Platypus*, Shaw).

ORDER VII.
PACHYDERMATA.
FAMILY 1.
PROBOSCIDIANA.
Elephas.
Mastodon (fossil).

FAMILY 2.
COMMON PACHYDERMATA.
Hippopotamus.
Sus (Hog).
Phacochœrus.
Dicotyles (Peccary).
Anoplotherium (fossil).
Rhinoceros.
Hyrax.
Palæotherium (fossil).
Lophiodon (fossil).
Tapir.

FAMILY 3.
SOLIPED.
Equus (Horse).

ORDER VIII.
RUMINANTIA.
(Without horns.)
Camelus.
Moschus.

(Horned.)
Cervus (Deer).
Camelopardalis (Giraffe).
Antelope.
Capra (Goat).
Ovis (Sheep).
Bos (Ox).

ORDER IX.
CETACEA.

FAMILY 1.
HERBIVOROUS.

Manatus (Lamantin).
Dugong (*Halicorus*, Illig.).
Stelleras (*Rytina*, Illig.).

FAMILY 2.
COMMON CETACEA.

Delphinus (Dolphin).
Narwhal (*Monodon*, L.).
Cachalot (*Physeter*, L.).
Balæna.

ZORNIA. A genus of curious, exotic, herbaceous plants, of the hedysarum division of the leguminous order. Seven species have been introduced to Britain from the Indies, Australia, North America, and Southern Africa; and four or five more are known. Two of the introduced species have perennial roots and quadrifoliate leaves, and require the protection of the greenhouse; the other five have annual roots and bifoliate leaves, and require the protection of the stove; both of the former, and most of the latter have yellow flowers; and all love a somewhat light soil, and bloom in July and August.

ZOSTERA. See WRACKGRASS.

ZUBR. See OX.

ZUCCAGNIA. A small genus of ornamental, exotic, bulbous-rooted plants, of the asphodel tribe. The green species, *Z. viridis*, was introduced to Britain from the Cape of Good Hope about 75 years ago; and has a height of 8 or 10 inches, and carries green flowers in August.

ZYGOPETALUM, a genus of ornamental, tropical, epiphytous plants, of the orchis family. It takes its name from the petals being joined at the base. Several species of great beauty, with flowers of variegated colours, have been introduced to British gardens from Demerara and Brazil. See the article ORCHIS.

ZYGOPHYLLUM. A diversified genus of ornamental, exotic, thalamiflorous plants, constituting the type of the natural order Zygophylleæ or Zygophylleaceæ. This order is nearly allied to the rue family; it belongs wholly to the tropics and to the warm parts of the temperate zones; and it comprises within the gardens of Britain 9 or 10 stove species, nearly 30 greenhouse species, and 3 or 4 hardy or half-hardy species belonging to the seven genera Zygophyllum, guiacum, tribulus, melianthus, fagonia, larrea, and porlieria. Some of the species are herbs, remarkable for the softness of their stems, and others are shrubs still more remarkable for the excessive hardness of their wood. A few are medicinal, some are curious, and many are ornamental. The name Zygophyllum signifies "yoked leaf," and alludes to the circumstance of the leaves growing in pairs. One herbaceous species of the genus zygophyllum, three low trailing species, and nine or 10 shrubby species, varying in height from 1 foot to 7 feet, have been introduced to Britain from Syria, Egypt, St. Jago, the Canary Islands, and the Cape of Good Hope. Most have yellow or orange-coloured flowers; and nearly all may be propagated from cuttings.

The herbaceous zygophyllum, or bean caper, *Z. fabago*, is the species best known, and possesses some medicinal reputation as an anthelmintic, and may be selected as a sufficient specimen of the whole genus. It is a native of Syria; and was introduced to Britain toward the close of the 16th century. Its root is thick and fleshy, and strikes deep into the ground, and will grow as thick as a man's arm; its stems are annual, and are proportionate in number to the age and size and vigour of the root, and are smooth, green, and jointed, and send out a few side branches, and usually attain a height of 3 or 4 feet; its leaves stands in pairs on footstalks of about an inch in length, and are smooth and fleshy like those of purslane, and have a bluish green colour; its flowers come out in twos and threes on short footstalks from the wings of the stems, and have each five roundish concave petals of a reddish or orange and white colour, and bloom from July till September; and its fruit are oblong, prismatic, five-sided capsules, and have their cells full of roundish seeds.

THE END.

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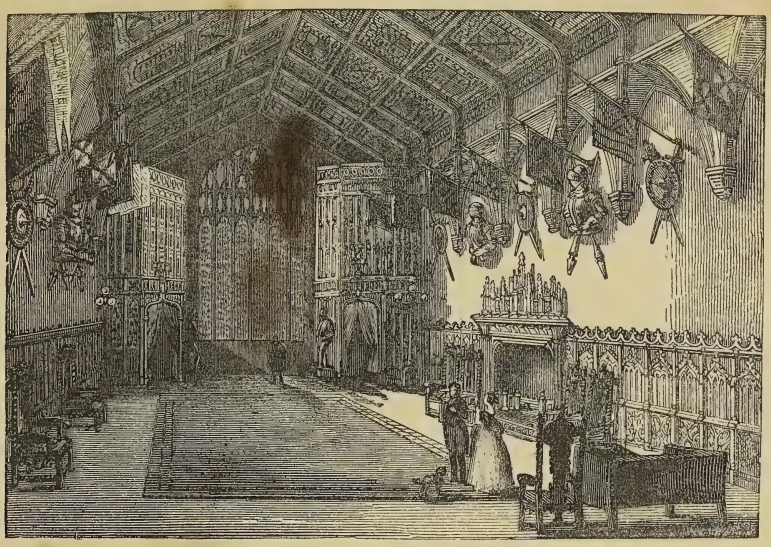

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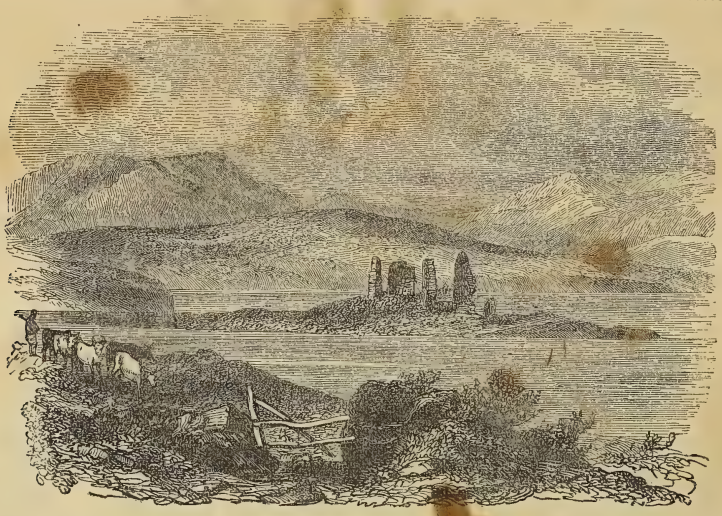

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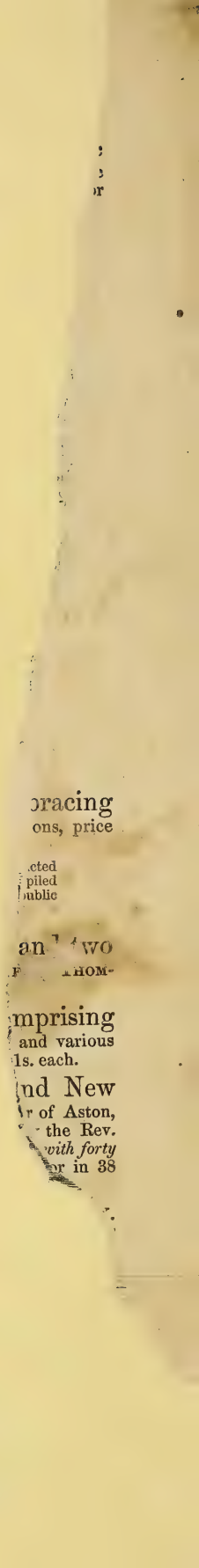
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